SCIENTIFIC AMERICAN
No. SUPPLEMENT. 340

Scientific American Supplement. Vol. XIV., No. 340. Scientific American, established 1845.

NEW YORK, JULY 8, 1882.

Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

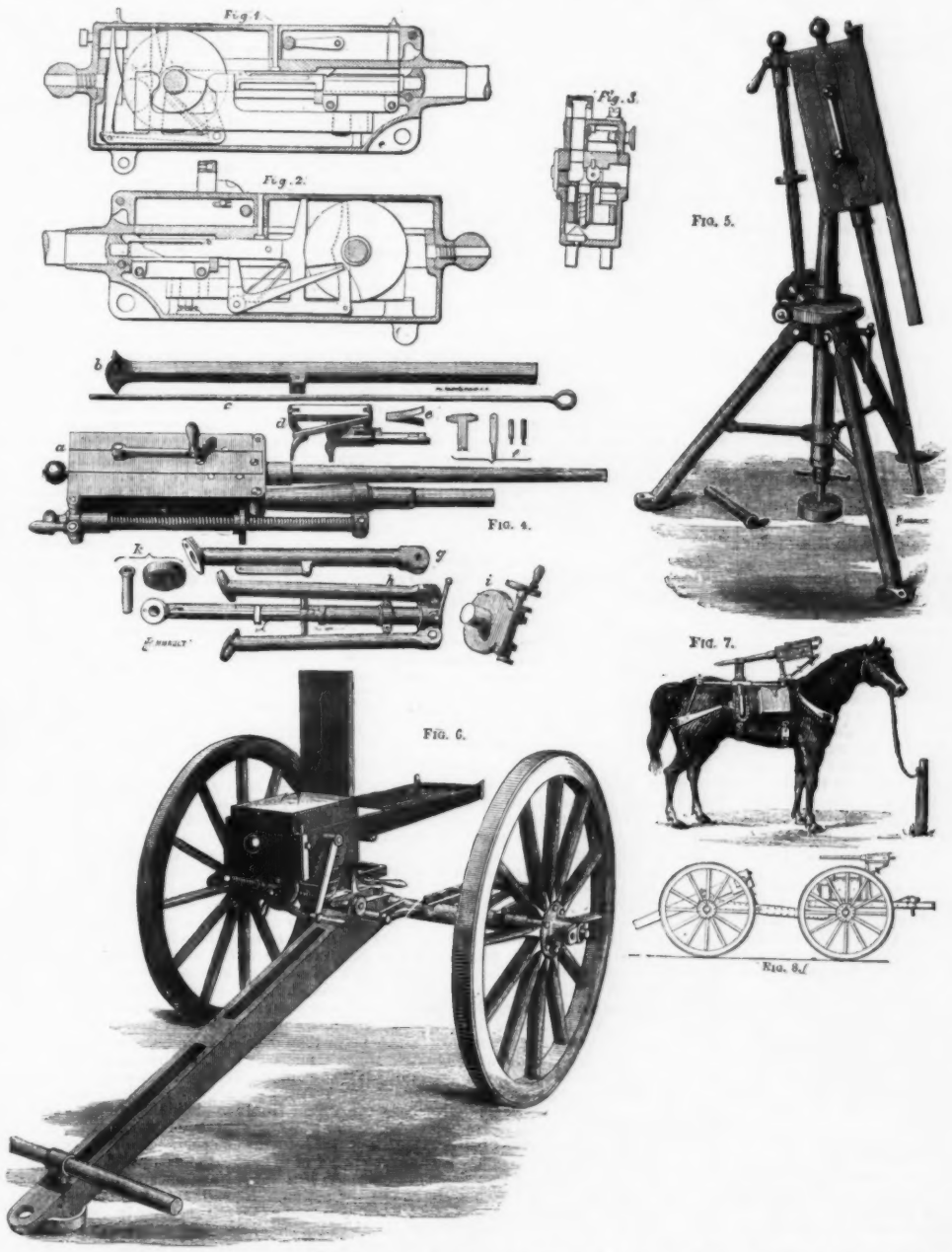
THE GARDNER MACHINE GUN.

THE British War Office authorities, acting on the request of the Admiralty, have given an order for 275 Gardner guns. The different dockyard construction officials are fitting a number of ships to receive this description of gun. We may, therefore, fairly conclude that the Gardner machine gun has, after exhaustive and comparative trials, established itself as a portion of the armament of iron-clad vessels of the Royal Navy.

In our engravings Figs. 1 to 3 show sections of action; Fig. 4 shows a single-barrel gun off its mountings, with spare lock and tools; Fig 5 shows a single-barrel gun on deck mounting, out of action; Fig. 6 is a five-barrel gun on carriage; Fig. 7 shows a one-barrel gun packed on horseback for transport; and Fig. 8 represents a one-barrel gun carried on limber of gun carriage. We will first state the gun's general construction, and then proceed to deal with its method of working in action.

The frame which incloses the action consists of a rectangular case made of a particular description of hardened bronze. On the fore upper surface of this case is fixed a hinged top case or cover. On the left back corner of the cover, when down upon the lower case or frame, is fixed the back sight, or more properly speaking the tangent. This has at its side a cam brake, which allows the tangent to be raised or lowered at will by a simple turn of the head of the cam. The cartridge feeder, which is movable, is placed in a slot cut in the fore end of the top case when down, and has a spring bolt to hold it securely in position, either when in or out of action; the feed of cartridges being continued through the slot on to the cartridge in the action. This action consists of a main crank or cam, having attached to it a journal that passes through the frame, and to which is joined a hand crank or handle.

The lock is very simple in construction. It consists of a very powerful frame, in the front of which is fixed the lock bolt; to this is attached the extractor. Within the lock bolt is the firing pin, which is acted upon by a bell-cranked hammer working on a pin at the head of its frame. A strong V-shaped mainspring of specially prepared steel acts upon the bell-crank hammer when released for sending forward the firing pin. The cartridge carrier is fixed just below the fore part of the lock bolt, and is a ledged plate having working through its center a movable diaphragm, which is forced downward by a hardened steel cone fixed in the gun frame. Within this frame is a controller bar that slides forward and backward by the action of the cam crank; this controller bar has a diagonal slot on its fore end. In continuation of the front end of the frame there is a cylindrical projection turned out to receive the breech end of the barrel in such a way as to insure a perfect fit. In the breech end of the barrel there is a half circle cut out from one side; into this cut from outside the frame runs a steel pin which fixes the barrel closely into its place in the frame, thus avoiding screwing or unscrewing. Hinged on the fore end of the bronze frame is a strong standard of the same metal, adapted to be shipped into a variety of sockets. At the base of this standard there is a long screw which passes up to, and works through a sleeve that is hinged to the rear end of the frame. This screw elevates or depresses the whole gun At the foot of the standard is the mechanism for giving lateral fire. This arrangement (*i*, Fig. 4) consists of a worm and gear with double screw for scattering movement to right or left, or left to right, as desired. The tripod (*h*, Fig. 4) on which the gun works, consists of a long socket with three lugs, to which are hinged three legs fixed at angles; the two front at 45 deg., the rear one at 60 deg. These legs are tied to a ring round the socket by tough steel rods, in such a way that the tripod can be closed like the framework of an umbrella. Screwed into the lower end of the long socket is a shackle which carries a T-headed bolt that passes through a slot in a circular deck plate of bronze, beneath which the bolt is turned by a screw handle, thus drawing up the bolt against the underneath part of the deck plate and tightening down the legs to the deck as shown in Fig. 5, so obtaining



THE GARDNER MACHINE GUN USED IN THE ENGLISH NAVY.

absolute rigidity and consequent avoidance of that vibration through which aim would be disturbed. The whole or any of the action parts can be removed and replaced by the fingers alone, without the assistance of tools, in 30 seconds.

In stating the working of the action parts when in process of loading and firing, we must suppose that the gun is laid ready for instant use with the cartridge feeder full, the lowest cartridge being down on the carrier. As soon as the handle attached to the main crank begins to revolve, a transverse movement begins through the action of the cam that works against the controlling bar. The carrier with the cartridge on it now works to the right until it comes opposite the bore at the breech end of the barrel, the carrier being in two parts side by side, one of which is quickly thrust downward entirely out of its original position.

No sooner is the cartridge opposite the bore than the eccentric crank which forces forward and backward the whole lock, pushes this lock forward, driving before it the cartridge into the barrel chamber ready for explosion. Here it must be remarked that the eccentric cam on the main crank and the arms on the lock frame are so arranged, that while the rotary motion of the crank is continuous the forward and backward movements of the lock and the sliding motion of the cartridge carrier are intermittent and alternate. Thus, when the pause in the transverse action of the cartridge carrier takes place, the eccentric throws forward the lock to drive before it the cartridge that is resting on the carrier. As the fore end of the lock pushes the cartridge into the breech of the barrel, a bevel on the left side of the fore end of the lock rides down the movable half of the carrier, thus leaving a space or opening on its right side through which an exploded cartridge case drops when drawn backward by the claw of the extractor. The lock with the extractor fixed on its upper surface reaches the rear end of the carrier one instant before a cartridge rolls down sideways on to the carrier. The flange of the cartridge therefore slides under the claw of the extractor. This is, therefore, never behind the cartridge, and has not to spring or pass over it for the purpose of extraction. While the lock is being thrown forward by the main crank, and before it reaches the cartridge on the carrier, a disk on the other side of the crank works round. This disk has cut in it a broad notch. This notch trips and releases the bell-crank that draws back the firing-pin to the cocking point, and releases it at the instant the base of the cartridge is in the breech of the barrel ready for firing. The back action of the cam withdraws the lock to its original position, and with it the extractor clutching an exploded cartridge, which rolls down through an opening at the bottom of the bronze frame. Therefore, at every revolution of the main crank a shot is fired and an empty cartridge is ejected. The long feeder, down which the cartridges slide, holds them by their flanges only. The cartridges are one over the other in a long row, and run rapidly down to the transversely acted upon carrier as fast as every loaded cartridge is carried into the bore. The cartridges can be placed in the feeder either singly or in tens and fifteens.

The Machine Gun Committee, in its report upon the experiments with eight guns, states "that the Gardner fire barrel fired 16,754 rounds during the trials, a number largely in excess of those fired by any other guns, as it was subsequently submitted to a special endurance trial of 1,500 rounds per barrel. The total number of jams was 24, being a percentage of 0·14. Several of these jams occurred at the commencement of the trial, and before the gun, which was a perfectly new one, had been properly adjusted. In the last 7,500 rounds fired on one afternoon for endurance, there were but five jams, viz., four failures to extract, and one cartridge nipped in the action, two of these jams being caused by using cartridges that had previously been dropped in the mud by accident. Leaving these two out, the percentage of jams on this occasion was only 0·04, or in the proportion of four failures in 10,000 rounds. The accuracy of fire was fair. The absolute rapidity of fire was only inferior to the ten-barrel Nordenfeldt at one stage of the trial, namely, that for exposure for a week in the open before resuming fire; the Gardner then succeeding in firing 405 rounds in half a minute. The feed is satisfactory, except that the slide could be removed without dropping the cartridges. It has no half-cock. The method of extraction is superior, as there is no spring required. The weight of the gun submitted was excessive for the number of barrels; but this weight appears

to the committee to be unnecessary. The simplicity of mechanism and the facility of removing and replacing parts is very marked; also the strength and solidity of the various components. This gun fired 330 rounds in 30 seconds.

The two-barrel Gardner gun fired 6,929 rounds during the trials without a single jam; the last 3,000 rounds being fired in 11 minutes 39 seconds, without cleaning or lubrication, and the gun appeared to work as well at the end of the trial as it did at the beginning. In rapidity it fulfilled the conditions; its speed was 236 rounds in half a minute. The simplicity of the mechanism is greater than that of the five-barrel Gardner gun, and consequently its parts are less liable to become deranged.—*Engineering.*

JOHN ROACH, OF NEW YORK.—HIS SHIP-BUILDING AND HIS VIEWS.

IN the current number of the SCIENTIFIC AMERICAN we give an interesting series of engravings, illustrating portions of the great ship-building works of John Roach & Sons, being the first part of the subjects comprised under the above title. A man of so many achievements as Mr. Roach must necessarily be a man of many ideas, and his views upon national industries, and how they may be practically promoted, ought to be of value, and will doubtless command the public attention. We, therefore, present the following abstract of his views as the second branch of our subject.

His own words will best express his views. And the same masterly capacity through which he projected and developed his immense business, manifests itself in speeches and papers. This is noteworthy especially as we seldom find literary skill and power of expression in a man noted for executive and business talent.

In all his considerations he gives American labor the first place. In this respect, he speaks of it as second to none in quality, better paid than any other workmen are paid for the same work, which implies better homes and a higher civilization. Their interests should be first considered.

He says: "Now let us look at another point—the vital point of this whole question—*labor.*

Suppose three different branches of business are started simultaneously in this country and in England—a woolen factory, a rolling mill, and a shipyard, each with a capacity of employing 1,000 men. The average wages of these skilled workmen in either of these shops here would be $2 a day, while in England they would be $1.20. The account would stand thus:

Wages 1,000 skilled American workmen, one week	$12,000
Wages 1,000 skilled English workmen, one week	7,200
Difference in wages in favor of English manufacturer, per week	$4,800
Wages advantage of English manufacturer, per year	$249,600

Now, I want to ask any practical and sensible man how long the American factory could be run and its men be kept employed, in competition with the English factory, unless one of two things was done: 1. Unless the wages of the American workmen were reduced to correspond with the wages of the English workmen; or, 2. Unless by a duty the American labor was protected against the half-paid labor of Europe, so as to enable the American employer to engage in the competition."

Throughout he never loses sight of the fact that skilled labor is as much in need of protection from foreign competition as does the manufacturing interest itself, and for the same reasons.

"It is certain, as I have said, that, to enable our manufacturers to compete with foreign manufacturers under a tariff for revenue only, the cost of American labor must be reduced. As the free trader, of course, disclaims the intention to close up any of our workshops, the only conclusion left him is the reduction of the wages paid to our labor. And so I want him to call meetings of the workingmen all over the country, and tell them frankly what his policy means: 'Workingmen of America, you are now occupying a position that does not belong to your class. You enjoy too many of the comforts of life. You provide too well for your family; you are too well fed and clothed; you are altogether too well off. Men of your class in other countries do not fare as you do. We can not compete with the manufacturers of these other countries, where labor is down-trodden and half paid, unless you will be content to receive the same half-pay wages and come down to the same squalid condition.'"

How forcibly he condenses the proof of his statements in this single picture: "Go to Castle Garden and inspect the thousands of poor, honest mechanics that land there. Look them over from head to foot, and you will see what the purchasing capacity of their day's wages is; then look at them again, after they have been here a few years, and mark the difference.

You ask me now, What shall we do? I answer: The American mechanic, manufacturer, merchant, and the American sailor ask no protection for brains, push, or ingenuity. All they ask is an equal chance in the competition."

Next after, and coupled with labor, he recognizes production. The resources of the country are in kind, extent, and quality unequaled. And, he argues, *why should we not control the carrying trade of our own products*

We do not sometimes realize the elastic power of growth which the country possesses as here shown.

"As for me I am content to let well enough alone. I find that Mr. Colquitt, one of the most eminent of the English statisticians, estimates that the United States is accumulating wealth at the rate of at least $2,500,000 a day, or in round numbers $1,000,000,000 a year, and that all the indications point to a continuance of this increasingly prosperous condition. We are now enjoying a general prosperity and growth in material wealth unparalleled in history.

I call your attention now to a few figures of iron production: In 1870 we took from the mines—

	Tons.
Of ore	3,655,215
To smelt this into pig required—	
Of limestone	1,500,000
Of coal	4,500,000
Of coke	1,000,000
Thus making of transportation more than	10,655,215

In the next ten years to 1880 these figures had doubled. Thus, in 1880, we took from the mines—

	Tons.
Of ore	7,709,708
To smelt this into pig required—	
Of limestone	3,169,149
Of coal	8,981,553
Of coke	2,277,555

An increase of 98 per cent., making of transportation a total of above 22,000,000 tons furnished merely to change the ore into pig."

From 1870 to 1880, years of a high tariff, the iron products of this country increased about 100 per cent. In those years it would be supposed that the increased demand would create an increased price; yet, though wages were higher by 20 per cent. between 1870 and 1880 than between 1850 and 1860, the price of iron was reduced under our high tariff by 25 per cent. This is a positive proof that to have cheap iron we must depend not upon a foreign market, but upon the competition, energy, and enterprise of our own people.

As proof of what I have just said, allow me again to refer to figures taken from official records, which show that from 1870 to 1881 average prices were as follows: Ship or tank plates, 2½ cents; flange iron, 4 cents; angle iron, 2½ cents; rivets, 4½ cents; average of the four classes of iron, 3⅜ cents, or 25 per cent. less than in 1850 and 1860.

These 7,709,708 tons of material, which was worth but 30 cents a ton in the mine, was increased in value to $100,557,685, when it had merely been made into iron and steel billets and muck bars.

The value it would attain when worked up into all the conceivable forms for use, from the plow to the knife-blade, from the ax to the surgeon's lancet, and from the ship-plate to the watch-spring, cannot be estimated. But what has been applied to create this value? Labor—nothing but labor."

Mr. Roach seldom speaks of an interest without, as in the foregoing passages, associating it with the conception of the general commercial industries of which it forms a part, thus bringing it constantly before the mind that prosperity in any line carries with it a benefit to many others.

Having been occupied during many years in the building of ships he turns his attention mainly to that branch of American industry of which he is a master. He says the building of American ships is a vast contributor to American prosperity. Let us see how this is. His own contracts will help us to comprehend this. If success is any guarantee of a man's judgment surely he deserves respectful attention.

"I will read you a little list of the articles that are required to carry out the contracts I have on hand or have undertaken between the 1st of January, 1880, and the 1st of January, 1882. They are: 3,450 tons of pig iron, in round numbers, representing a value of $86,250; manufactured iron plates, bars, angles, rivets, forgings, etc., 47,824,000 pounds, representing a value of $1,673,840; copper, 805,000 pounds, representing a value of $193,200. Then, without giving a detailed account of the value of every item, there is lead, 127,509 pounds; lumber, 6,750,000 feet; coal, 18,000 tons.

Here is a sum total of $3,031,565 worth of supplies bought in this country by one yard. The shipyards of Harlan & Hollingsworth, Cramp & Sons, and others, use goods of the same character.

The history of the world does not show so vast a development as that of our coasting trade in the last ten years.

Look at the figures. Counting in the contracts already in hand that cannot be completed until 1882, in the ten years from 1872 we have built 120 iron screw steamships, of a total tonnage of 230,000 tons. We have also built 25 wooden screw steamers, of 27,563 tons. This makes a total steam tonnage built for our coasting and foreign trade of nearly 260,000 tons, 230,000 tons of it iron steamships; while in 1870 there did not exist in this country the rolling mills and shipyards required to construct an iron ship such as we have to-day.

Referring for comparison to the ocean-going steam tonnage of the world in 1860, we find that it consisted of 338 steamers, with tonnage of 431,000, divided as follows:

NATION.	No.	Tonnage.
Great Britain	156	250,000
United States	53	71,000
All other nations	130	150,000
Total	338	471,000
Ocean-going steam tonnage built in U. S. since 1872	145	257,563

What a grand showing this is! We have built in ten years more steam ocean-going tonnage than England possessed in 1860, though she began to build the iron ship in 1840, and had liberally encouraged the establishment of shipyards, paying millions yearly in postal contracts to induce the investment of capital in the foreign carrying trade.

More than that: in these ten years we have built four times as much steam tonnage as we owned in 1860. . . .

This coasting trade cannot justly be called a monopoly. While its vast earnings have been preserved to our own people, the rates of transportation between our States have been reduced steadily, till they are lower than anywhere else in the world where similar wages are paid. The coast marine and the railroads are the great channels through which our internal commerce is conducted and our surplus products brought to the seaboard. But when we have brought them that far on their way—not more than one-quarter or one-third the distance—to the world's markets, we leave them for foreign carriers to transport the remaining distance. By so doing, for the carrying of our mails, passengers, and freights on the ocean, we pay every year from $60,000,000 to $90,000,000 to foreign carriers. . . .

What we have done with the iron ship since 1872, in the face of financial discouragement, is sufficient proof of what we can do to regain our place as ocean carriers, if a permanent policy and a wise one be adopted by the nation. *It is no small thing to be able to say that this country is to-day the second iron shipbuilding country of the world—second only to England—and that, without reducing the cost of American labor, we have reduced the original cost of the iron ship to within 12 per cent. of what it is in England, and can build a ship having no superior anywhere.*"

And he might here fairly add that to him belongs the credit.

"I have shown that dear capital, well-paid labor, and high taxes cannot compete in manufacturing or shipowning with low taxes, cheap labor, and cheap capital. . . .

The simple amount of it is that a tariff for revenue only is nothing but *free trade in disguise.* It can be seen at once that the American workingman is left out in the cold. . . .

A tariff for revenue only would allow the products to be poured in upon us of foreign factories, which pay nothing for the support of American institutions."

Referring to the developed resources of the country he returns again to his argument and points out our true policy:

"Have the men engaged in transportation no interest in this?

Shall we leave these 22,000,000 tons of ore, coal, and limestone buried in our own soil, and encourage their development in a foreign land, simply because labor is cheaper, and consequently productions of all kinds cheaper? Will any one say what the effect would be to this nation of drawing each year from our financial resources and sending it abroad to purchase our annual supply? Would not this increase the cost of iron in the country we purchase it from?

Shall this transportation, shown to be so immense, be done in this country or in a foreign one? And what would be the loss to our inland carrying-trade if this vast freightage from the mine to the furnace were shut off?

Besides, this is only the first freightage; made into pig and into various forms and shapes, it is then distributed into all parts of the land, to be worked up into all forms for use. So it furnishes transportation again and again until it reaches the merchant's counter. Remember this transportation is labor.

Referring to figures previously quoted he adds:

". . . Ninety per cent of this enormous sum has been spent at home for labor, which has not been reduced to the European price, and helped to give the farmer his home market. By these home-built locomotives and cars we bring our surplus products to the seaboard to put them into ships. But then we are told that while we can build the locomotive and the car, we cannot build the ship, though that is built out of the same material, from the same forest and mine, and though the labor required to convert 100 tons of pig-iron into locomotives is much greater than it is to put it into the finished ship, and just as high priced. But we had a policy for building the locomotive, by finding a use for it, and you see the result. . . .

What has made England the richest nation and the largest manufacturing nation in the world? Her resources in iron and coal, and the use she has made of them. She has neither cotton nor breadstuffs nor the power to produce them, and is dependent upon us for these necessaries of life, while we have these and the coal and iron in boundless abundance besides. And for ourselves, I firmly believe that were it not for iron, and the use we have made of it, you could not hold this immense territory known as the United States under one central government. Then our brethren beyond the Rocky Mountains would have to sail round Cape Horn, 15,000 miles, to come to make laws for the nation, or down the Pacific Ocean, crossing the Isthmus of Panama, again reshipping at Aspinwall to New York. All of our patriotism, love of country, even the influences of the Christian religion, could not control this vast territory under one central government. Our brethren would say we cannot suffer this great inconvenience. We must have a government of our own. With all the great natural advantages of this country, if this resource of iron had been withheld, would we not be apt to cry that the Great Father of the Universe made a mistake in not giving iron to develop the other resources? And when we have the iron, shall we now leave it in the mine undeveloped, and depend on foreigners to supply a material of so vast importance to us, and with no other reason to give, only that we refuse to degrade and crush labor? . . .

No other country in the world has developed as we have in the last ten years. We have protected our industries, and aided in the development of our agricultural resources through the building of railroads and opening up land communication to market. We have built up our manufacturing interests beyond all our expectations, and by so doing have given a valuable and profitable home market to our farmers. This wonderful development we owe to protection. Had it not been for this protection at the close of our civil war our factories would have been as scarce on the land as our ships in the foreign trade were on the sea, for we had given no protection to the ship. This wise policy of protecting our industries kept the factories open, and when the hundreds of thousands of men who went to the war returned home they found employment in the factories and workshops; but when the sailors were done with fighting they found no ships to employ them. And, together with the loss of ships, we had lost the American hold on the foreign carrying trade. . . .

The drain consequent upon buying ships abroad proves too great to be borne. Could England ever have owned and maintained her $574,000,000 worth of ships if she had had to buy them from another country? To keep this fleet up, not counting the annual cost of repairs, to build the new ships required to replace those lost and worn out, and to meet the demands of increased trade, costs not less than 10 per cent of the whole value, or $57,000,000 yearly. Could any nation expect to maintain such a mighty interest as this if, instead of being able to build its ships and tools, it was dependent upon another nation for them, and must annually send millions upon millions abroad to support the working people of that other nation? Could we afford to own such a fleet if we had bought it abroad? Could we pay out annually the millions necessary to keep it renewed? What effect would the taking of that great amount of labor out of our market have upon that market, and what effect in comparison upon the market which we favored with it?

Would she (England), do you think, for one moment depend upon a foreign nation for the ships to carry these products to market?"

Here he gives a conclusion in few and convincing words:

"All history backs me in holding that *no nation can become to any extent a ship-owning nation that is not able to build its own ships.* Besides that, the only security of the shipowner lies in his ability to get a ship always at the time he wants it, in peace or war, and to do that he must depend upon the home market. For if we close our shipyards and go to England for our ships, as we must, what should we do in case of any war—on account of which England would not be able or willing to furnish us ships? There can be neither safety nor security in dependency."

And this he argues to be true in times of peace, where there is competition for the carrying trade, as it is obviously true in the event of war:

"It is a most significant fact that all the other nations are begging to do our carrying business, while it is ourselves who have the business to be done.

Do not think I am too sanguine, gentlemen, in my hope that the day is not far distant when we shall accomplish the same grand result in supplying ourselves with the cheapest and best ships that we have with the locomotive. I could, from my own experience, state to you many things showing how little we had in a mechanical way to start with, and justifying my expectations. In the shop where I served my time, for instance, the first steamer that crossed the Atlantic—the old Savannah—was built. The first iron-planing machine used in America was brought from England, and we imported a man also to run it. His name was John Barton, a name well known among the machinists of New York. I remember how I used to watch him, and think what a wonderful man he was. I now have boys in my workshop, with only one year's experience, who do what we then had to import a man to do. A protective tariff induced our capitalists to begin building planes

This gave the workmen better wages; they came to us from abroad by the thousand, and we stopped importing either men or machinery."

"Is it on any conceivable ground a safe policy for us to become dependent upon a foreign nation for our ships? Consider the vast and constantly-increasing products we have to place in the markets of the world. We have by many millions of tons more surplus heavy products to be carried long distances than has any other nation. We exported last year over 11,000,000 tons. At the same rate of increase during the next ten years as during the last ten, in 1890 we shall export over 50,000,000 tons. We should require this year, to place ourselves in our true position on the ocean, an outlay of some $75,000,000 to buy ships with; and each year, with its increased trade, would add to this large sum In what interest can the man be working who advises us to buy from a foreign builder all these ships which we now need, and shall need, if we are to gain the place that belongs to us? How can any American propose, in view of our future, to make us constantly dependent upon outsiders for anything which we have the means and ability to supply ourselves with? What are the great ocean steamship lines but the continuation of the trunk lines in transporting our products to market? Why should we control those products on the land, and the moment we get them to the seaboard deliver them over to foreigners? By that method we pay the freight for from 1,000 to 2,000 miles to our own people, and for from 3,000 to 4,500 miles to foreigners, when certainly the greater part of it should go to support American enterprise and labor. What would be thought of a proposition to place our trunk lines in the hands of English companies, and have them run under the control of England, with her flag hoisted on the cars? Yet we might do that with equally as much reason as surrender to them our products at the seaboard."

Mr. Roach possesses the true eloquence which springs from comprehensively grasping a large subject. His words have none of the "spread-eagle" trait which characterizes the utterances of many of our public men. They possess the eloquence of eloquent *facts*.

"It is this high-priced labor that makes the cost of the ship, as of our manufactured products, greater than it is in Europe. It is American labor that we protect by our protective tariff. And I say this is right. I say that we must continue to protect American labor. But shall we, then, leave our forests and mines undeveloped because it has ever been and is the policy of our government to furnish labor with more favorable conditions than it knows elsewhere? Is there no way to build up American interests other than to crush down American labor? I will leave that question for the American people to answer. It is a pressing question that must be answered soon, in regard to our shipping at least. And anybody that, with the cry of Free Trade or any other, declares that American labor must be thrown into sudden competition with the down-trodden and crushed labor of Europe will very soon find that it needs our sympathy rather than our opposition. It will fall and be ground out of sight beneath the iron heel of that American labor whose elevation and advancement is one of the strong pillars on which the splendid structure of this free government rests secure."

WORKPEOPLE'S AID SOCIETIES IN ALSACE.

FOR many years past the industrial establishments of Alsace have set the world an example in the care taken of and the provisions made for the wellbeing of their workpeople. The dwellings provided for the hands at Mulhouse, Colmar and other industrial centers of Alsace, are well known, and the sick and burial societies of the district are further advanced than in most countries of Europe. As in a recent publication, "Etudes Statistiques sur l'Industrie de l'Alsace," one of the deputies has given authoritative information on these subjects, and especially on the aid societies, it gives us an opportunity of laying some interesting details before our readers.

The association of the workpeople in Alsace for the purposes of mutual aid has been so well established that, as the rule rather than the exception, almost all industrial establishments of the country have aid societies, which are supported by the joint efforts of masters and men. In some isolated cases these societies are conducted by the hands only, as, for instance, at Wesserling, where such a society was founded as early as the year 1823. An inquiry instituted by the industrial society of Mulhouse has shown that in 1868, in 59 mills of the Upper Rhine, there were 48 aid societies, with 25,000 members, which number has been considerably increased since. At the same time there were in France 5,288 authorized societies, with 782,498 members, and a capital of £160,000. All are established for the purpose of assisting those of their members who are incapacitated from work by paying expenses during sickness and supporting them in old age and when disabled by infirmities. Almost all these societies attend to the funerals of their members, and some support women during confinement, assist young people when they are going to be married, and young men when called into the army.

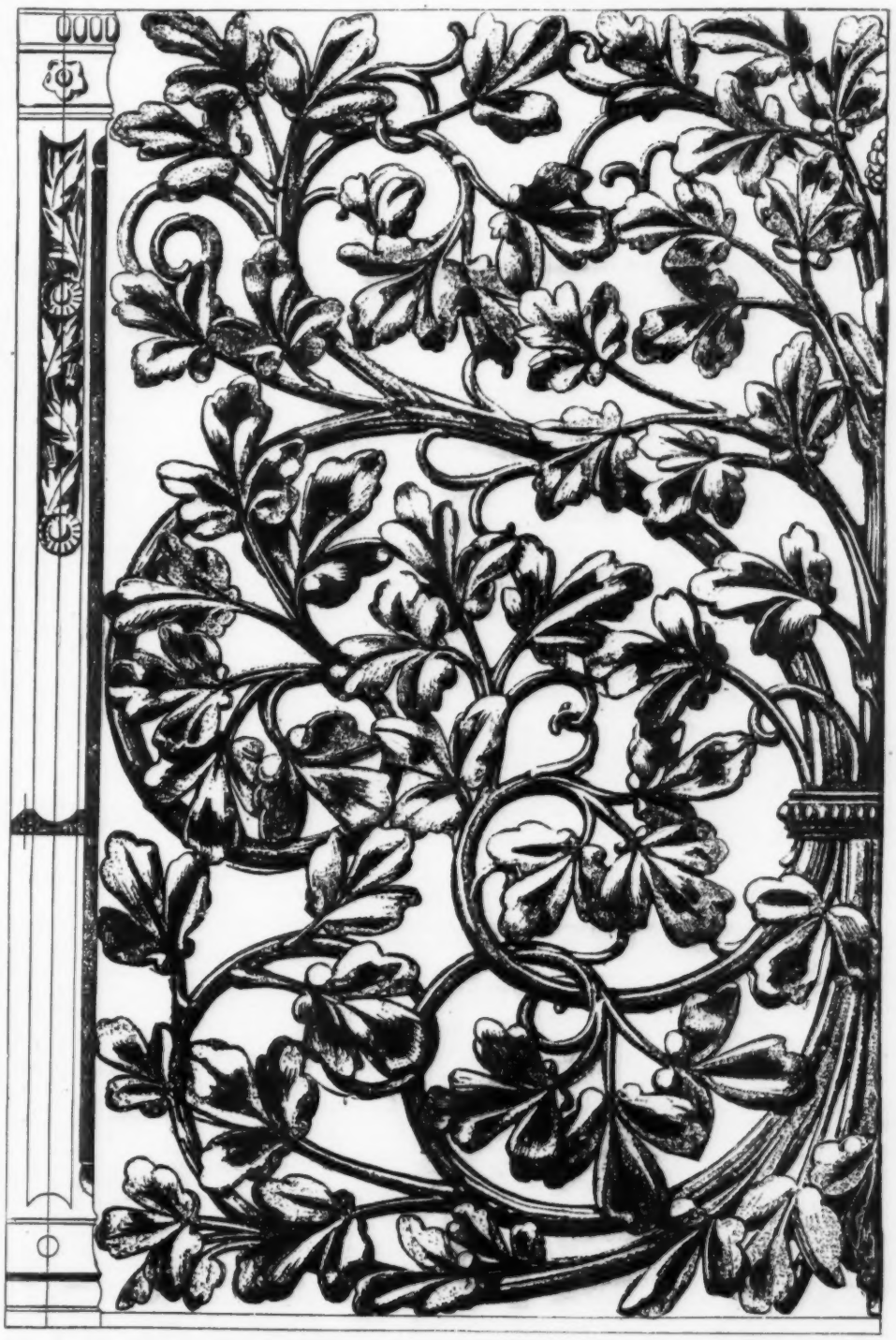
The organization of these societies in the country and the towns is different according to their means. The conditions of entrance are also not everywhere alike. In some cases participation is compulsory for all hands employed in a mill; in others it is optional; in some the entrance depends upon the length of time of service, and the age and position of the hands; in others the masters pay all expenses; in others the hands defray their own; but in most instances they are divided. The provision for pensioners is mostly in force in the country, especially at Thann, Rothau, Logelbach, Wesserling, Munster, etc., where the same society assists the sick and pensions those who are incapacitated for work. This function of the societies is, however, more difficult to carry out in towns where the hands have a less settled residence, and change oftener. In the country, however, most hands have a fixed domicile, with garden or field, so that, especially when a man has worked for one mill during his whole lifetime, a provision for old age is more easy to carry out. This explains why, at Mulhouse for instance, the societies only assist their members during sickness or in case of death, and the contributions there are so regulated that they suffice for this. At the utmost the society forms a reserve fund for extraordinary cases, such as, for instance, an epidemic. Where, in towns, the society makes provision for old age, it is generally in consequence of the contribution of the master, who then also adds to it the condition that the recipient must not leave his establishment. Indeed, it is a fact that most of these societies receive considerable assistance from the masters, and that they could not exist without them, the hands by themselves being unable to support them This is rather a melancholy observation to make, and is not, on one or two suppositions, exactly to the credit of the workpeople; for it proves that either their demands upon the funds are too frequent or that they are reluctant to part with a sufficiently important share of their wages to form thus an insurance fund for sickness; or otherwise that their wages are too low to permit of their doing so.

We gather from the statistics communicated that, as a rule, the contributions are about 4 per cent of the wages, half of which only is paid by the hands, while the other half is contributed by the masters, and out of this fund the hands obtain medical assistance during sickness for themselves and their families and a contribution in money which, with good management of the funds, is often as much as 40 per cent. of the wages, and in some cases furnishes a small reserve fund. Where as much as five per cent. of the wages is contributed the treasurer is able to provide the necessary funds for pensions in case of old age.

From the foregoing it will be seen that these societies have rather a precarious existence, and that their success depends almost entirely upon the compulsory participation of their members.

CAST IRON PANEL BY LE DUC.

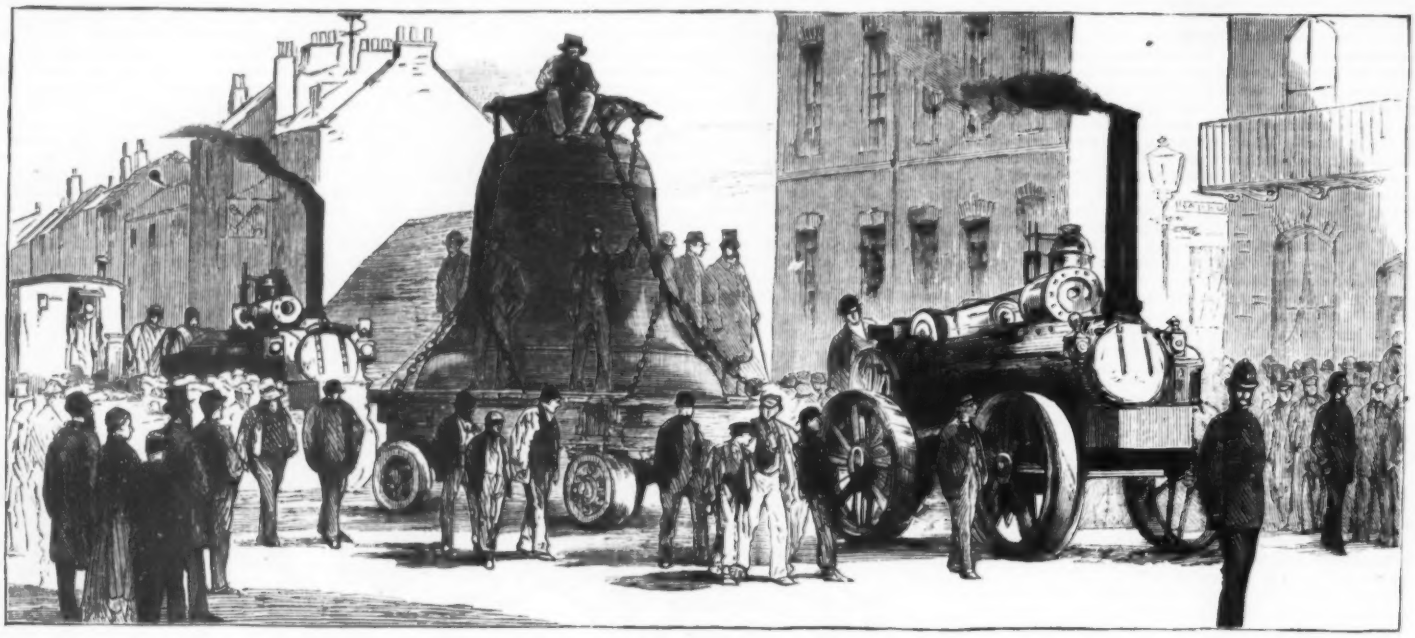
THE half-panel of cast-iron work is for the Imperial Company, Orleans, and, it must be confessed, bears more the imprint of wrought iron both in the distribution of the foliage and manner of its growth. We give herewith a facsimile reproduction of this wash-drawing, as drawn and tinted by Viollet-le-Duc himself.—*Building News.*



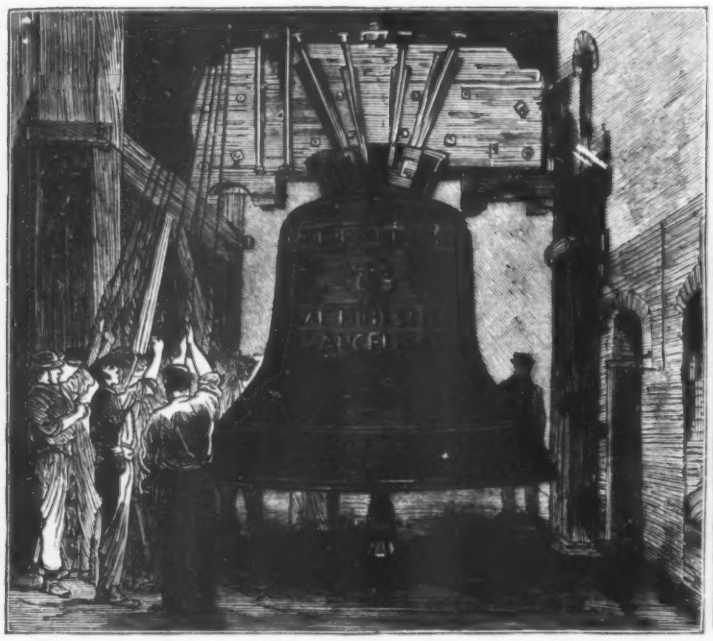
SUGGESTIONS IN DECORATIVE ART—CAST IRON PANEL, ORLEANS—DESIGNED AND DRAWN BY VIOLLET LE DUC, ARCHITECT.

RE-LIGHTING SAFETY LAMPS BY ELECTRICITY.

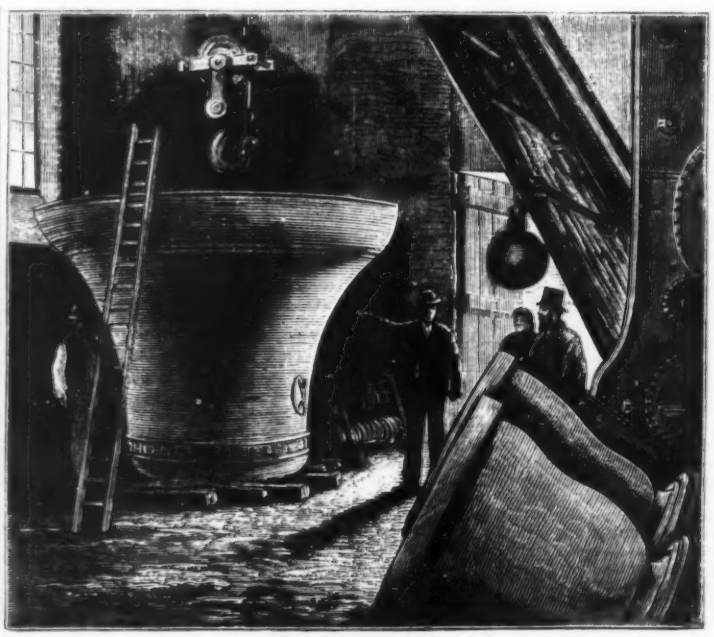
WHENEVER safety lamps are extinguished by firedamp, they have to be taken to the surface to be re-lighted, unless, indeed, the state of the colliery permits of there being a lamp-room underground; and during the time thus occupied the miners must necessarily remain idle, if the stock of lamps be not sufficiently extensive to permit of several being held in reserve. Struck with the loss of time and expense which this proceeding entails, M. Hubert, Ingénieur des Mines, and M. Henry Durant, lately brought before the Hainault Society of Mining Engineers, a method of re-lighting, by means of electricity, safety lamps which have become extinguished by firedamp—and that without opening them or removing them from the air which may at any moment become explosive. The bottom or reservoir of the lamp is provided with two tubes of metal, in which fit tightly two wooden plugs. These serve to hold and to insulate two copper wires connected by a short platinum wire passing close to the wick. On making contact with a battery, the electric current raises the platinum wire to a white heat and lights the lamp. Various batteries have been tried for this purpose, but as portability and at the same time high power were required, the bichromate battery was ultimately selected. This consists of a glass cell with wide mouth, containing bichromate of potash and water acidulated with one-tenth its weight of sulphuric acid. Generally, one zinc and one carbon pole are immersed in this liquid; but, in order to increase the surface and therefore the intensity, Messrs. Hubert and Durant employ two zinc and four carbon plates. They also propose eventually to supersede the bichromate battery by that of Daniell, re enforced by a Faure accumulator. In order to avoid the sparks which are produced on breaking contact, and which would ignite an explosive mixture, two spiral springs hold the zinc and carbon plates clear of the exciting liquid, so that to make the current pass it is necessary to press the lamp firmly down upon the electrodes. As soon as the lamp is re-lighted the pressure on the electrodes is released; they rise from the liquid, the current no longer passes, and consequently no sparks are produced on breaking contact. Existing lamps may be modified, so as to be lighted by electricity, at a cost not exceeding 6d. each; and it is fairly claimed that this cost, together with that of the battery, will soon be repaid by the saving of oil resulting from only lighting the lamps when they are required for use, instead of at the mouth of the shaft. A practical demonstration of the new system was given before the members, who regarded it as amply conclusive.



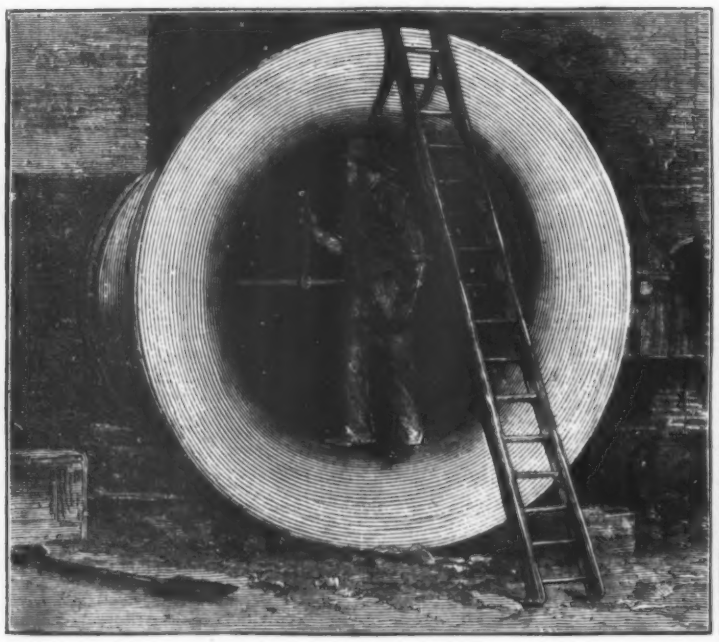
THE REMOVAL: LEAVING LOUGHBOROUGH FOR LONDON.



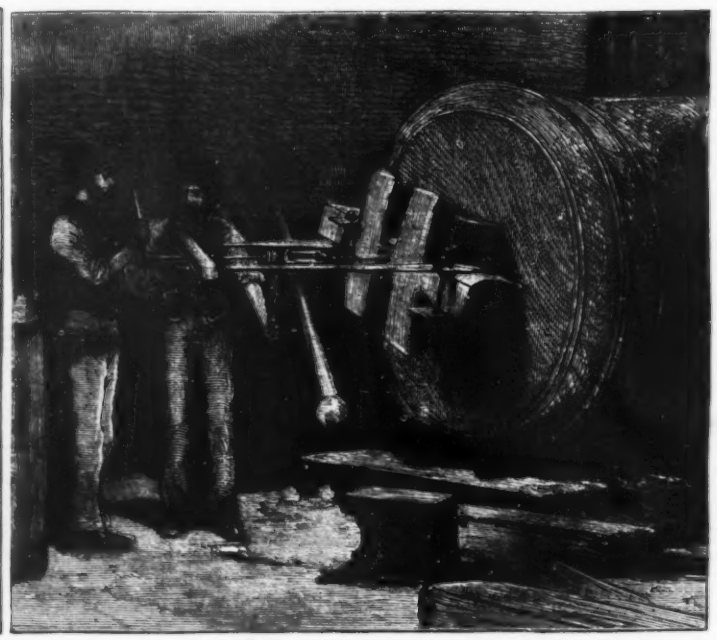
HUNG IN FOUNDRY FOR EXPERIMENTAL SWINGING.



POSITION FOR THE FIRST TESTING OF TONE.



BORING FOR THE CLAPPER-BOLT FROM THE INSIDE.



BORING FOR THE CLAPPER-BOLT FROM THE OUTSIDE.

"GREAT PAUL:" THE NEW BELL FOR ST. PAUL'S CATHEDRAL.

THERMIC CONDUCTIVITY OF MINERALS AND ROCKS.

By J. THOULET.

AMONG the considerations needful for ascertaining the mode of formation of minerals and rocks, one of the most important data is that of the temperature to which they may be brought by convection. The author names "thermic resistance" the time required for a constant quantity of heat, which in his experiments is 34", proceeding from a source at 100° in contact with the lower surface of the rock to reach the upper surface, at a distance of 0·010 meter. This thermic resistance is a function of the coefficient of conductivity, as defined by Fourier and Lamé. The novelty of the author's method is the substitution of a precise evaluation of times for the determination of temperatures.—*Comptes Rendus.*

A NEW PERPETUAL MOTION.

IN the Belgian Academy, M. Plateau has lately called attention to a small illusion. He describes an arrangement which at first sight, he says, might be thought capable of realizing perpetual motion. A capillary tube is inserted obliquely in distilled water, so that the latter nearly fills it. Into this liquid column, at the top, dips the small orifice of another tube, which reaches a little way in the same oblique direction, then turns downward, the vertical portion being wider, and not reaching the water. It then forms a siphon, the shorter branch of which is immersed in a liquid in equilibrium, while the longer descends several centimeters below the surface of that liquid. Does it not appear as though the water should flow incessantly through the siphon, and, regaining the vessel, be engaged in perpetual circulation? As a matter of fact, the water is drawn upward in the vertical portion of tube till its free surface reaches a part of the oblique part of the same tube, when it stops. M. Plateau accounts for the effects by suction exerted by a small concave liquid surface between the two tubes.

THE NEW GREAT BELL FOR ST. PAUL'S.

"GREAT PAUL" has successfully accomplished his progress from the works of Messrs. Taylor, of Loughborough, in Leicestershire. The bell left the foundry on Thursday, May 11, and it was expected to arrive at the cathedral on Thursday week, but the state of the roads in Buckinghamshire made that impossible. The huge mass of some seventeen tons was mounted upon a trolly with low wheels of extraordinary breadth. This carriage weighed five tons more, and thus brought up the total weight to twenty-two tons. It was attached to a steam traction engine, which, under ordinary circumstances, drew it with surprising ease; but it was preceded by another engine, ready to be attached by means of an iron wire rope in case of need, but ordinarily dragging a movable reservoir of water and a great van, in which were stowed away all the tools and implements, and where all the engineers and workmen cooked, ate, and slept. At many places, and notably at St. Albans, peals were rung from the steeples. At half past three on Saturday afternoon the bell arrived at Highgate, where it was detained the whole of the next day, the regulations of the street traffic in the metropolis forbidding the passage of traction-engines after seven in the morning or on Sunday. The start from Highgate was not made until about two o'clock on Monday morning, May 22. About seven the "Angel" was reached, and at a few minutes before eight Great Paul reached his journey's end, and was delivered over, safe and in good condition, to the charge of Mr. Penrose. The arrangements for sliding the bell from the trolly by means of a grooved launch platform had been so well planned by the cathedral surveyor, that, with wonderful ease, the heavy bell was hauled on to the sliding-way and drawn down to the door of the south-west tower, where it was left for the night.

Everything had been prepared under the direction of Mr. Penrose with such exactness that, while not an inch of stonework had been unnecessarily cut or removed, there was still just room enough for the wide-lipped bell to be hauled through the door and up the incline from the yard to the floor of the tower. The steps and the stones at the lower part of the doorway had been removed, an outline in section of the bell cut in wood having been used to make sure that the bell would pass without getting even a scratch. The headstock, or yoke, into which the cannons of the bell are fastened by iron straps and bolts, is formed of three oak beams, each 9 ft. 9 in. long, and 2 ft. 6 in. broad, set on their sides and bolted together, with iron plates, or flitches, sandwiched between the two outer and the center one. The structure looks somewhat like a great axle-tree; the axles, however, being represented by the short iron gudgeons, 6in. in diameter, set in iron bedplates at each end, and on which the balanced mass of headstock and bell will swing. The weight of the headstock alone is nearly three tons, the clapper over 4 cwt., the crown staple to which the clapper is attached about as much more, and the clapper-bolt, by which the two sections of the clapper are fastened through the headstock, not far from another 2 cwt. To these must be added the weight of the iron straps and bolts by which the "cannons" of the bell are fastened in the headstock, and a total weight of nearly four tons is made up, in addition to the 16 tons 14 cwt. 2 qrs. 19 lb., which Great Paul brings to scale.

The bell is to have no connection with the clock, and is not to be struck by a hammer; but is to be swung and used for a service-bell, or on rarer occasions, and it may be hoped at very long intervals of time, to be tolled. An ingenious modification of the lever-arm, by which smaller bells are rung, has been devised, by which it will be possible for two men, and for three or four men with ease, to "chime" the bell—that is, to swing it sufficiently to cause the clapper to strike one side of the sound-bow. A wooden bar, about 10 ft. long, fixed at right angles to the top of the head-stock at one end, will have the rope attached, by which the ringers will pull. At the other end of the head-stock, and on the same side of the bell as the ringers stand, will be another long lever-bar, having a heavy weight attached by a rope, the rope, however, being so long, that the weight rests on the ground until the motion of the bell, exaggerated by the length of the arm, lifts the weight, when a jerk is given, and the rate at which bell and clapper are moving being suddenly altered, the stroke is obtained. When the swinging motion has once been got up, eight or ten strokes a minute may be got. How far the bell will be heard above the roar of London life and traffic is, while this is written, as yet unknown; but on his trial in the foundry at Loughborough, every stroke was heard for three or four miles in the country around, and in one direction the deep boom is said to have been audible at a distance of seven miles. The above particulars are from the *Building News*, and our engravings from the *London Graphic*.

DEDICATION OF THE GREAT BELL.

"GREAT PAUL," the big new bell of London, has been safely put in place, and was blessed on Saturday, June 3, after evensong. The procession of clergy and choir of St. Paul's Cathedral, ascending by the grand staircase, passed along the corridor over the south side aisle leading to the belfry, stopping at the entrance to the narrow, winding stairs by which the upper part of the clock tower is reached. The service was intoned by the Rev. Dr. Simpson, the choir singing Psalms CXXX. (*De Profundis*), lxvii., xxix., and cl. In the special prayers of dedication which followed there were these sentences: "O everlasting God, whom no man hath seen at any time, although Thou dost speak to the souls of men through the things that Thou hast made; receive, we beseech Thee, this bell, which is offered by Thy people for the service of Thy Holy Church, and bless it to the spiritual well-being of Thy servants, that it may remind us of Thy presence in life and in death. . . . Grant, O Lord, that whosoever, by reason of sickness or any other necessity, shall be hindered from coming into the house of the Lord, may, when he hears this bell, in heart and mind ascend to Thee, and find with Thee peace and comfort through Jesus Christ our Lord." The hymn "When morning gilds the skies" ("Hymns Ancient and Modern," No. 303) was sung, and the collect for St. Paul's Day having been read, the blessing was given by the Rev. Canon Gregory. Immediately the deep note of "Great Paul" sounded full and sweet through the vaulted passage, and soon afterward a joyous answer rang out from the peal in the north tower. The churchyard was filled with a crowd waiting to hear the great bell.

THE GREAT ORGAN AT THE CRYSTAL PALACE.

THE Handel Festival Organ in the Crystal Palace is now being reconstructed and enlarged by its builders, Messrs. Gray & Davison of Euston Road. It is almost certain that this organ has been heard by more people than have heard any other musical instrument in the world. Those living in London and the suburbs who have not listened to its sounds must be few indeed. A large organ is so ingeniously constructed, that, regarded merely as a piece of mechanism,

FIG. 1.

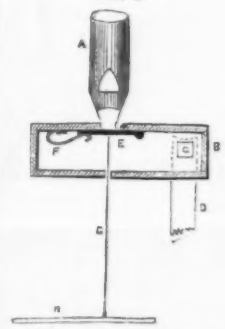
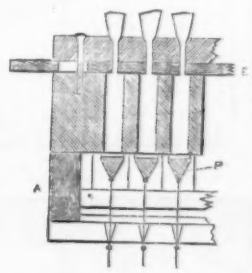


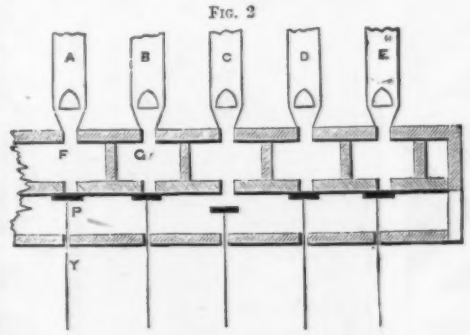
FIG. 4.



it has a special interest for engineers; and we have no doubt that we shall please a great many of our readers by giving them particulars of the changes now being carried out by Messrs. Gray & Davison. But although organ music is familiar to most persons, few understand precisely how it is produced, and we propose here, in order that what we have to say concerning the Crystal Palace organ may be quite intelligible, to explain as simply and briefly as possible the general principles involved in the construction of all organs, which principles are modified according to the taste and skill of different makers and the purposes for which the organ is designed. This done, we shall give a sketch of the history of the Crystal Palace organ, and details of the alterations and improvements being effected in it.

An organ consists of an external case containing within it a large number of pipes, each of which is a separate wind instrument competent to produce but one note. In large organs there are several thousand pipes. Thus the Crystal Palace instrument will have 4,394 pipes, and the organist can produce as many sounds. All these pipes may be classed under two heads, namely, (1) flue pipes, and (2) reed pipes. The flue pipe is neither more nor less than a whistle, the principle on which it acts and the details of

FIG. 2.

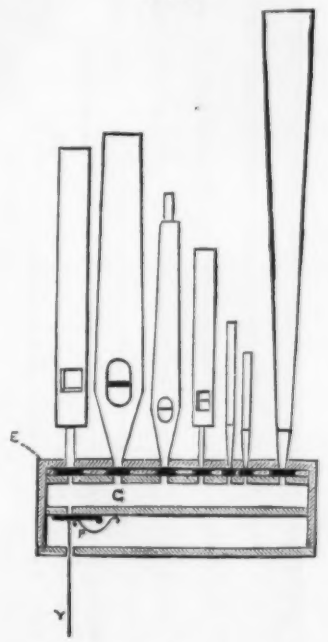


its construction being practically the same as that of a dog whistle, or a "penny whistle." The size of these whistles varies in the organ, the largest being a wooden pipe 2 ft. square and 32 ft. long, while the smallest is ¼ in. long and ¼ in. in diameter. The largest produces the deepest musical note which is audible, namely, C C C C. Its sound is an octave below the lowest C on the grand pianoforte. The reed pipe is so called because it has at its base a reed or vibrating tongue, which gives a peculiar character to the tone. Thus the clarionette and bassoon are reed instruments. The harmonium is indebted solely to reeds for its music. In the organ, reed pipes exist of various sizes, but they are seldom made more than 16 ft. long, which gives a note in unison with the lowest C of the grand pianoforte.

Every one knows that organs are fitted with what are known as stops, and that these are named as Diapason, Oboe, Voix Celeste, and so on. The sounds produced differ from each other not only in pitch, but in character or *timbre*. This difference is produced by modifications in the form of the pipes, especially at the mouth, and the character of the reed pipe is, of course, different from that of the flue pipe. So much premised, it will be understood that air under pressure must be provided, by admitting which to the pipes they are made to sound; and the duty of the organist consists in admitting air to certain pipes and excluding it from others by the use of the keys or "manuals," and the pedals, which are really a second and larger set of keys, played on by the feet, just as the manuals are played on by the fingers, and by the "draw stops," which, as will be explained presently, control the various series of pipes. All large organs are subdivided, that is to say, the outer case contains two or more separate organs, each of which can be played on distinctly from all the others, having its own special keyboard. Thus the Crystal Palace organ has four separate sets of manuals and a set of pedals, and contains five distinct instruments, namely, the great organ, swell organ, choir organ, solo organ, and pedal organ. Arrangements are, moreover, made, which will be explained further on, by which any two or three of these can be "coupled" together, so that practically the organist can perform on all five instruments at once if he wishes, or on one only.

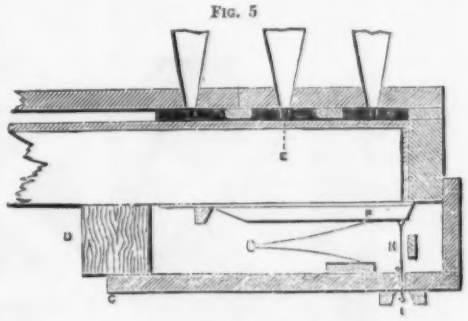
Compressed air is always known technically by the organ builder as "wind," and its pressure is expressed in terms of

FIG. 3.



inches of water which it will balance. The pressure varies in large instruments, some pipes requiring a greater pressure than others to make them "speak" properly. The normal pressure in an ordinary church organ is about 3 in., and a stop is said to be "on a 3 in. wind" or "a 4 in. wind," and so on. The wind is obtained by the aid of large bellows, worked by men, or steam, or water or gas engines. The bellows are called "feeders," and deliver into a large wind chest, loaded at the top to the proper pressure. The bellows and reservoir are rectangular, and made expansive by means of ribs of wood, hinged and gusseted with leather. An illustration of the blowing apparatus for the Crystal Palace organ will be found on page 5421. It is worked by three of Joy's water-pressure engines. It stands below the organ, as will be gathered from the general sectional view, next page. It will be seen that it is a large affair, capable of delivering a vast quantity of wind. It is of the utmost importance that the pressure should not vary in the organ, and for this reason four feeders deliver into each primary reservoir. The wind is led away from the reservoirs to the organ by means of wind trunks, which are simply rectangular wooden pipes of large size. We have now to explain how the admission to and exclusion from the various musical pipes is effected. This is the most complex subject with

FIG. 5.



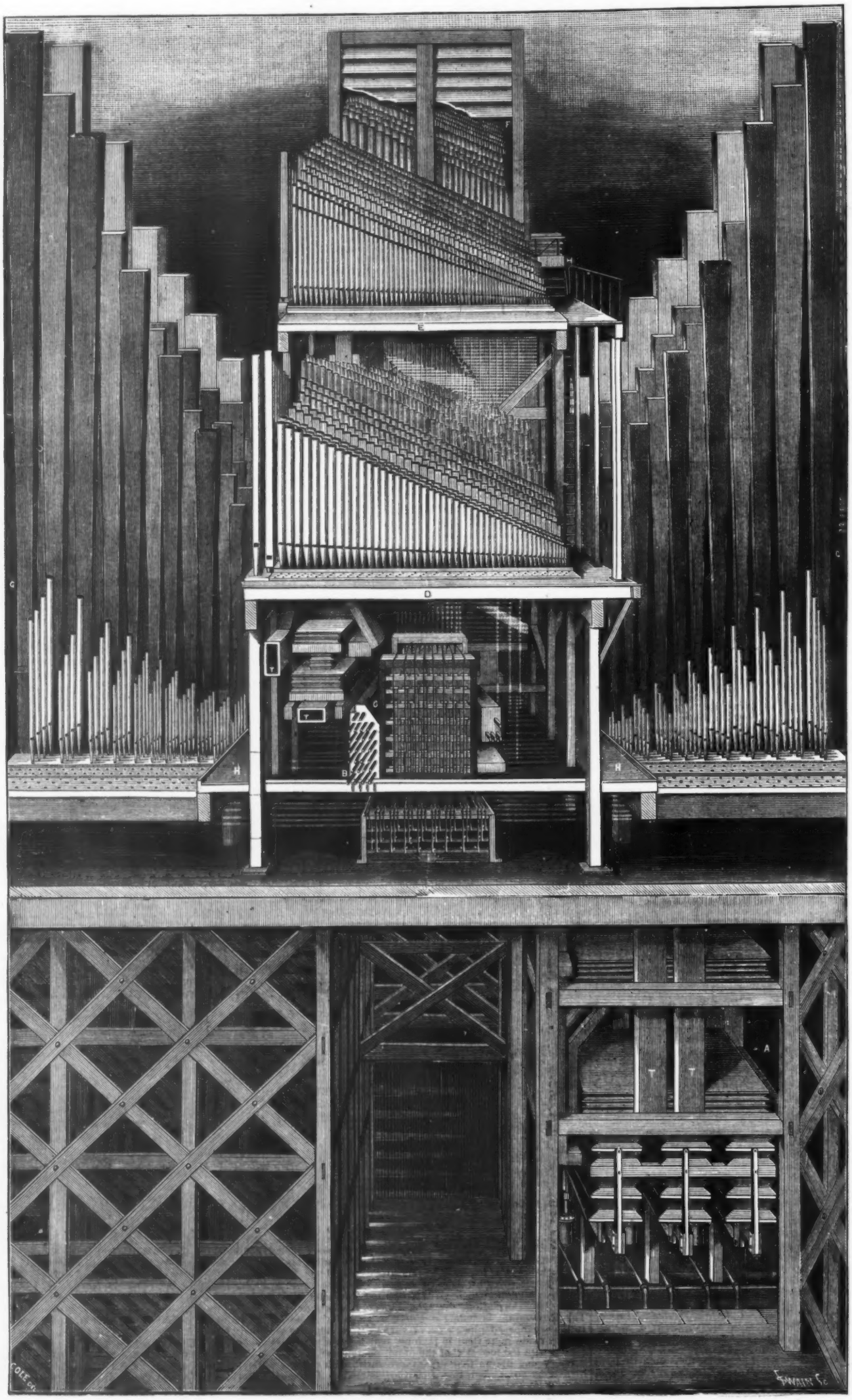
which we have to deal, and if our readers will once grasp this all the rest will be readily understood.

Let us take the case of one pipe only to begin with. The pipe, A, Fig. 1, stands on the top of a shallow box called the sound board, B. Wind is conveyed to this box from the reservoir or wind chest by the wind trunk, D, and is admitted to the box, B, through the aperture, C. Under the foot of the pipe, A, is placed a valve called a pallet, E, hinged at one end, and kept up by a spring, F; when up wind cannot get into the pipe. H is a key; when this key is pressed down by the organist's finger it pulls E open by means of the "tracker" or rod, G, and the pipe then "speaks" or sounds so long as H is kept down.

Now, we have said that in one organ case are included one or more organs. Each organ includes several stops. Thus in the Crystal Palace organ the great organ has nineteen, particulars of which will be found further on. The key-board or manual of the great organ has fifty-eight keys;

SECTION THROUGH THE GREAT ORGAN AT THE CRYSTAL PALACE.

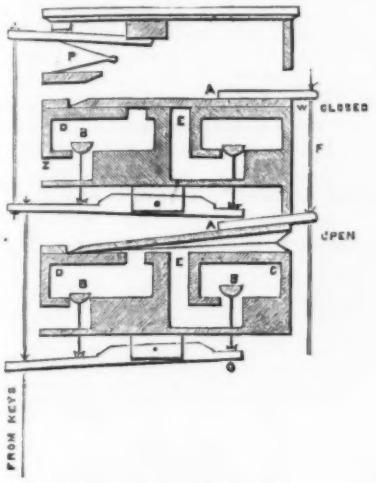
MESSRS. GRAY AND DAVISON, BUILDERS, EUSTON ROAD, LONDON.



but each one of these keys must be able to govern each one of the nineteen stops. Each stop is for each key represented by one pipe; that is to say, there are nineteen pipes to each key.* It is evident that if the same system were adopted that we have sketched in Fig. 1, each key must be fitted with nineteen separate pallets—which is obviously out of the question. The difficulty is got over very simply and effectually. Let us confine our attention to one key, namely, the middle C of the key-board.

The great organ has a sound board all to itself, standing just inside the front of the organ case, in the middle. This

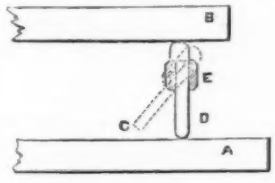
FIG. 6



sound-box is large enough to give standing room to 1,624 pipes.† These pipes are arranged in straight rows from front to back—fifty-eight pipes in each row counting from right to left along the front of the organ, and nineteen pipes deep from front to back. Fig. 2 is a diagram intended to make the construction of a sound board intelligible, but it does not show the sound-board of any particular organ.

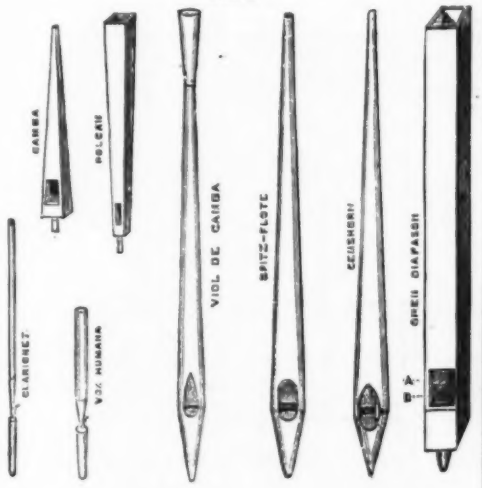
The pipes, A B C D E, stand on F, as in Fig. 1, but the box is divided into several longitudinal spaces, G, by distance pieces. These spaces are known technically as "grooves." P are the pallets which can be pulled down by the trackers, Y. There is only one pallet to each groove, and the result is that when any key is pressed down wind is admitted to

FIG. 7



the corresponding groove, and thence to all the pipes standing on that groove. In the sketch the pallet for pipe C is pulled down, and all the pipes on the groove controlled by that pallet may be sounding If we assume the key to be the middle C, then the open diapason, Claribel flute, double trumpet, oboe, etc., will sound each its own middle C.‡ In this way then it will be readily understood that a single pallet can control as many pipes as there are stops in a sound-board. Looked at in a direction at right angles to that in which Fig. 2 appears, we have an arrangement of pipes similar to Fig. 3. In Fig. 2 we see the several pipes of but one stop. In Fig. 3 we see but one pipe each, say the middle C pipe, of seven stops.

FIG. 8



We have now to consider the construction and use of what are known as the "draw stops," namely, the handles seen arranged at each side of the organist, and by pulling out or pushing in which he causes the rows of pipes constituting a stop to speak or be silent at will. It will be understood that if nothing more were provided than what we have sketched, as soon as the key was pressed down and the corresponding pallet opened, all pipes belonging to that key would speak at once. The organ would, therefore, always be at its full power. There would be no means of modulating intensity of sound, and the effect from a musical aspect would be disastrous. Means are therefore provided to shut off any one row of pipes. Under each row of pipes is placed a slip of mahogany, called a "slider," which may be about 3 in. wide and ⅜ in. thick, varying, however, in size with the pipes it controls. In this are bored fifty-eight holes, one for each pipe. These sliders can be moved endwise. When in one position they shut all the holes; when in another they leave them all open. They move in, so to speak, the thickness of the sound-board on top of the sound-box, the grooves in which they slide being at right angles to the grooves, G, in Fig. 2 Fig. 3 is supposed to be a section at right angles to Fig. 2, on the middle C, through an organ sound-board with seven stops. P is the pallet; G is the groove. The black lines, E, show the ends of the draw stop sliders, which are all supposed to be in now, so that none of the pipes would speak even though the pallet, P, were opened by the tracker, Y.

Figures 4 and 5, which are slightly modified from those given in Hopkins and Rimbault's great treatise on the organ, show how the various parts, the principal of whose action is sketched in diagram, Figs. 1, 2, and 3, are usually constructed. Fig. 4 is a sectional front view of a wind chest and sound box. Fig. 5 is a section at right angles of the same thing to a larger scale. In both E is the draw stop slider, and P the pallets. The air is admitted from the reservoir or wind chest through the bottom or side, C or D, an aperture not shown being made for the purpose.

In large organs the pallets are, of necessity, of considerable size, because they have to admit air enough to supply each a great many large pipes. Their range of motion is also considerable. The area of a pallet may be as much as 30 square inches, and the pressure on it with a 14 in. wind would be nearly a ½ lb. to the square inch; to open it would, therefore, require a pull of nearly 25 lb. But a good organ will speak when the key of a manual is depressed about ¼ in. Consequently there must be a loss of leverage between the key and the pallet, and the result would be an intolerable strain on the fingers of the organist. In the modern instrument the touch is, however, nearly as light as that of a pianoforte, but in the old instruments it was almost impossible to play music requiring rapid execution, save by a very musular musician, using only a limited number of stops. In large modern organs the organist when he presses down a key does not pull down the pallet in a groove, but a secondary and very small valve, which admits air to what is known as the "pneumatic lever," which then does all the heavy work. In Fig. 11 we give illustrations of the pneumatic levers of the great organ at the Crystal Palace. Fig. 6 is a section, not of the Crystal Palace pneumatic action, but a diagram intended to illustrate the principle involved. A small bellows, A, is fitted on the top of a box containing two little valves, B B. These valves are coupled to the back fall, O, which is in turn coupled by a tracker to the key. When the key is pressed down one of the valves, B, is opened as shown, while the other is shut. Wind now passes from the chamber, C, into the bellows, and lifting its top board, pulls on the rod, F, which is coupled to the pallet of the key pressed down. The moment the key is released by the organist one valve closes and the other opens and permits the air in the space, E D, to escape, when the bellows at once collapse, and the pallet is closed by the falling of W and F. The work of the organist consists in opening the little valve, B, which has an area of not much over one square inch. In Fig. 6 two pneumatic levers are shown,

FIG. 10

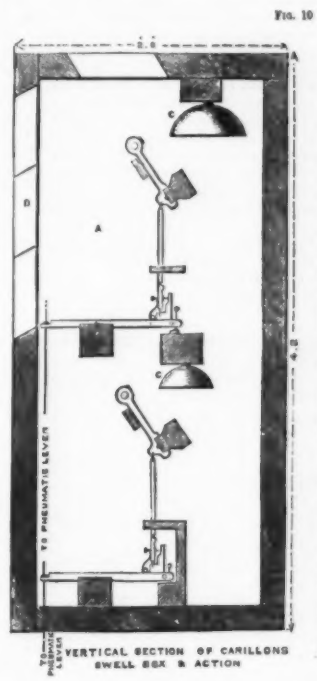
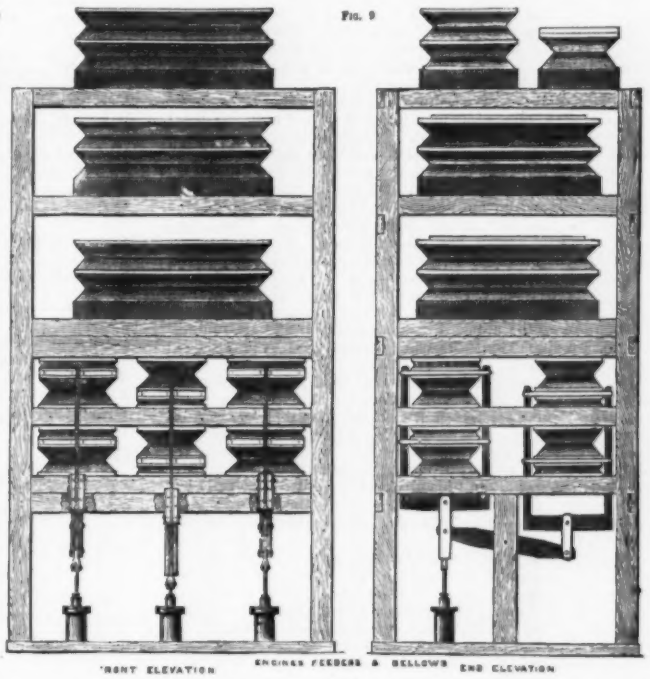


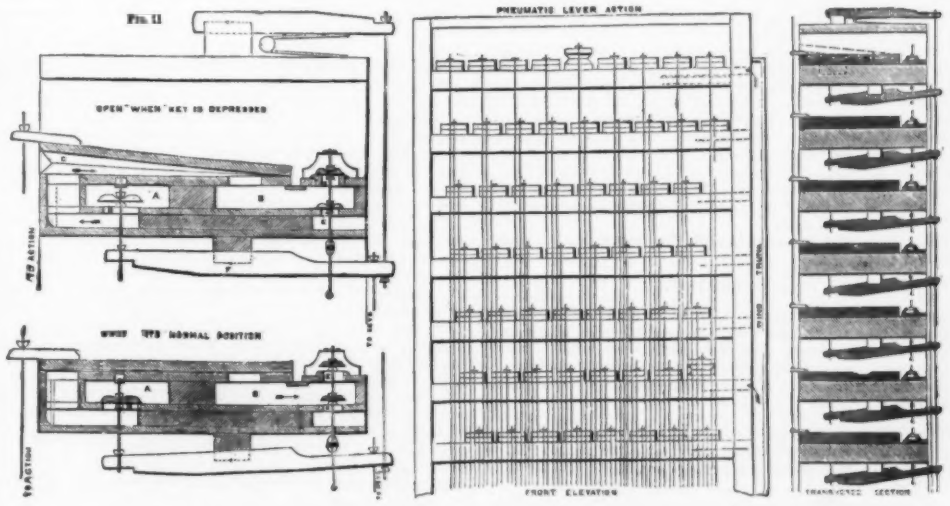
FIG. 9



the top one closed, the lower one open. A spring is used to keep the valves closed, and the tension of this spring is really the measure of the "touch" of the instrument. It is found in practice that the pneumatic lever is so quick in its action that the most rapid and delicate passages can be played without difficulty, the pipes speaking simultaneously with the depression of the keys. The bellows are too wide to permit them all to be put in one row, one to each key; therefore they are disposed, as shown, in tiers, one above the other. Usually every fifth bellows is placed in the same row, and there are five or more vertical tiers.

The pedal mechanism does not call for special description, pedals being nothing more than enlarged keys; but even to pedals the pneumatic action is now adapted, to lighten the work of the organist. The most important section remaining to be described is the coupling. We have said that any two or more of the organs can be coupled to each other; and this is usually done by coupling the keys. Thus, when the great and swell, for example, are coupled, the keys on the swell manual move when the great manual is played upon, the effect being the same as though there was one player to each organ. There are, besides, couplers by which one section of a keyboard is coupled to another. Thus, when the organist plays one set of notes with his fingers, all the same notes one octave above or below are played at the same time. The pedals, again, can be made to act on the great or other organ, and so on. The arrangements by which this apparently complex work is done are extremely simple. There are several devices in use; if we describe one it will suffice. In Fig. 7, A B are the inner ends of two keys, one, A, being, let us say, for the choir, and the other, B, for the great organ. E is a bar of wood running across the organ, in which bar are as many holes as there are keys. In each hole slides a hard wood peg, C. The bar, E, can be partially turned on its axis by an iron treadle, worked by the foot of the organist. When in the position shown by the full lines, the pegs, C, couple A and B. It is impossible to play on A without moving the keys of B at the same time; but it is possible to play on B and not move the keys, A. In the former case

FIG. 11



* There are really many more, but as the additional pipes go from three to five to a note, each set of these may, for clearness, be regarded as one pipe only.

† This is not strictly true, and there are really four sound-boards to the "great organ." In the Crystal Palace organ some of the pipes are placed where there is room at a little distance, the wind being led to them by tubes. These pipes are said to be "conveyanced off."

‡ Only what are known as "foundation stops" will give this note, but to avoid confusion we keep for the moment all reference to the harmonic pipes from the body of this article.

the pegs, C, work up and down in the holes in the cross-bar, E. If, however, the bar, E, be made to revolve through about one-sixth of a circle, the pegs, C, will assume the position shown in the dotted line, and will not be touched by the keys. This arrangement has been superseded by mechanism more complex and efficient, but the principle involved is clearly shown.

The arrangement of the sound-boards within an organ case varies with the design of the case, the space available, etc.; and the various trackers radiate in different directions, and are led off in various ways. We give a section through the Palace organ, which illustrates our meaning. But all the devices for leading the trackers are very simple, being for the most part bell cranks in wood or iron. The distance to which trackers are led is sometimes very considerable, as much as 80 ft. or 90 ft. not being unknown.

Concerning the music produced by an organ, it is well to explain that the instrument is not a collection of pipes intended to imitate well-known instruments. There are, it is true, such pipes, as, for example, the trumpet and the flute; but the diapason has no true analogue in a band, and the same may be said of many other stops.

In a foot-note we have alluded to the fact that there may be more than one pipe in a given stop to a note. These pipes are known as "mixture," "furniture," sesquialtera," and so on. Their purpose is to sound the harmonics to a foundation note. Thus, when we put down the middle C key, the diapason sounds C, but the other pipes we have just named sound harmonics to it. The harmonic pipes are arranged in rows or "ranks," as they are called. Thus, for instance, we may have one open diapason pipe, two principals, three twelfths, and four fifteenths, or, in all, ten pipes to a single diapason note. Again, in a "four-rank" stop we may have, from C C to middle B, tones 19, 22, 26, 29, and so on. The introduction of these harmonics adds power and richness to the music, for reasons which will be understood in a moment by those who have studied even the elements of acoustics.

The varying character of the sounds produced by different stops is due to the shape and material of the pipes, and to some other influences which are not without interest. Thus the voix celeste, usually regarded as the most beautiful and plaintive stop known, owes its charm, curiously enough, to the fact that each note is produced by two pipes, which are first tuned accurately in unison, and then put out of tune by very slightly raising the pitch of one of them. In Fig. 8 we give examples of the form of a few pipes, each of which is named.

We give on page 5420 a longitudinal section of the organ, as it would be seen if the front of the case with the keyboards were removed, as well as the seats in the orchestra. The organ stands on a stout platform or floor, 40 ft. wide by about 25 ft. deep, which is supported by timber framing, as shown, rising from the main floor of the Palace. At A will be seen the blowing apparatus, with the water-pressure engines beneath. These engines are extremely simple, and their construction is too well-known to need description. They have been supplied by Mr. David Joy, of Anerley Park. At B are shown some of the rods of a few of the draw stops. Right in front, at C, is the pneumatic lever arrangement of the great organ, D, above which is the solo organ, E. At the very top is shown the swell organ, F. All its pipes are inclosed in a box, the front of which is fitted with louvre boards, which can be opened and closed by a pedal, so as to modify or augment the loudness of the sound produced. The lines seen running right and left are trackers to the sound-boards of the pedal organ, G G, on each side of the instrument. Many of the pipes are shown in their places, but a large number are omitted to show those behind, but the sound-boards, with the holes in them ready to receive the pipes, are shown. The choir organ is behind, and entirely hidden by the great organ. H and H are gangways, by which access is obtained to various portions of the organ. T T are wind trunks. Fig. 11 gives sections of one set of pneumatic levers. All the rest are nearly identical, save in dimensions. Fig. 9 is an enlarged view of the blowing apparatus.

Our readers are now, we venture to hope, in a position to understand what the Crystal Palace organ is. When the first of the series of Handel Festivals was contemplated, it was felt that an organ of considerable power, especially in the deep bass department, was desirable, if not indeed essential. The original idea was to erect an instrument simply for "filling up" effects in the choruses, etc., the presence of the full orchestra rendering the more delicate organ effects unnecessary. Later on, however, it was thought that by adopting a more comprehensive scheme the organ might be utilized by the Crystal Palace Company as a solo instrument and for general purposes. Accordingly a specification was drawn up for a grand organ of four manuals and pedals, and eventually carried out. A portion of the instrument in this form—a large number of the stops not being inserted, but "prepared for" only—was finished, and used at the first rehearsal in 1857, and afterward at the first Festival performance in 1859. The organ was further developed in the year 1871, when some of the "prepared for" stops were supplied. It was, however, still left incomplete, and so it has remained until now.

We subjoin the specification of the organ in its reconstructed form:

SPECIFICATION.

Four manuals—overhanging— C C to A, 58 notes and pedals concave, but not radiating—C C C to F 30 notes. Pneumatic action to each clavier. Twelve double French vertical feeders, supplying four bellows, communicating with the various inner wind reservoirs. Motive power—three of Joy's patent hydraulic engines.

		Ft.
Great organ:		
Double open diapason	metal	16
Large open diapason	"	8
Open diapason	"	8
Flute-à-pavillon	"	8
Harmonic flute	"	8
Claribel flute	wood	8
Quint	metal	6
Octave	"	4
Flute octaviante	"	4
Twelfth	"	3
Super-octave	"	2
Harmonic piccolo	"	2
Mixture, four ranks	"	
Furniture, three ranks	"	
Cymbal, five ranks	"	
Double trumpet	"	16
Posaune	"	8
Harmonic trumpet	"	8
Clarion	"	4
Swell organ:		
Bourdon	wood	16
Open diapason	metal	8
Keraulophon	"	8
Concert flute	wood	8
Octave	metal	4
Flute octaviante	"	4
Twelfth	"	3
Super-octave	"	2
Harmonic flageolet	"	2
Mixture, four ranks	"	
Furniture, three ranks	"	
Contra-fagotto	"	16
Cornopean	"	8
Oboe	"	8
Echo tromba	"	8
Vox humana	"	8
Clarion	"	4
Tremulant.		
Choir organ:		
Lieblich Bourdon	wood	16
Gamba	metal	8
Salcional	"	8
Voix celeste	"	8
Clarionet flute	wood	8
Gemshorn	metal	4
Harmonic flute	"	4
Claribel flute	wood	4
Spitz flute	metal	2
Harmonic piccolo	"	2
Clarionet	"	8
Orchestral oboe	"	8
Tremulant.		
Solo organ:		
Grand open diapason	metal	8
Flute harmonique	"	8
Flute octaviante harmonique	"	4
Corno di bassetto	"	8
Grand tromba	"	8
Carillons		
Pedal organ:		
Double open diapason	wood	32
Open diapason	"	16
Open diapason	metal	16
Violone	wood	16
Bourdon	"	16
Quint	"	12
Octave	metal	8
Violoncello	wood	8
Mixture, four ranks	metal	
Contra-bombarde	wood	32
Contra-posaune	"	32
Trombone	metal	16
Ophicleide	wood	16
Clarion	metal	8

Couplers:

Swell to great, unison.	Choir to great.
Swell to great, sub-octave.	Choir octave.
Swell to great, super-octave.	Solo to pedal.
Swell to choir.	Swell to pedal.
Solo to great.	Great to pedal.
Sforzando (great to swell).	Choir to pedal.

RECAPITULATION.

19	stops in the great organ,	1,624	pipes.	
17	" swell "	1,264	"	
12	" choir "	696	"	
6	" solo "	290	"	and 37 bells.
14	" pedal "	510	"	
68	sounding stops,	4,394	pipes.	
14	mechanical stops, couplers, tremulants, etc.			

Total, 82 stops.

The space occupied by the instrument is 40 ft. wide by 24 ft. deep, exclusive of that taken up by the five bellows behind, which have hitherto been ordinarily blown by ten men, supplying the various reservoirs inside the organ with wind at different pressures. It has now been decided to remodel the instrument and complete it in all respects, applying entirely new bellows and feeders adapted for blowing by water engines. The motive power will be supplied, as we have said, by three hydraulic engines, one of 6½ in., one of 5½ in., and one of 5¼ in., driven by water from the tower of the Palace at an estimated minimum pressure of 100 lb. to the square inch. The blowing apparatus is arranged under the orchestra so as to be seen at work by any visitors to the Crystal Palace who are curious enough to inspect it. Though in so enormous, and at the same time lightly constructed a building, it will probably surprise some to learn that this organ, although more powerful, is not so large as several well-known instruments far more favorably situated in smaller and more substantial halls.

The wind pressures have been revised, and in some departments increased, but not to the extreme to which this has been carried in certain recent instances. It is nevertheless believed that the power will prove ample, without being "blatant" and oppressive from very din, as in some modern organs voiced on the so-called "German systems." It has also been an object to avoid the undue predominance of "Reeds" and reedy Gambas, which give some of our large modern organs on the French system so much the effect of gigantic harmoniums. At the same time every variety of tone is at command, while mere "vain repetitions" are avoided. One of the new features consists in the addition of three octaves of carillons or bells inclosed in a swell box with Venetian louvres, so as to be capable of crescendo and diminuendo effects. The range is from gamut G upwards. The hammers are put in motion by the pneumatic key action of the solo organ. Fig. 10 is an end view. The bells are hung on horizontal bars and struck by hammers arranged like those of a piano, but of course very much larger. The organ will be revoiced throughout.

Until now there were but two sets of pneumatic levers, one to the great organ and one to the swell for lightening the touch. There will hereafter be five—namely, one to each of the four manual claviers, and one to the pedal clavier. These will be of the most improved modern construction, with double exhaust. The wind pressures will range from 4 in. to 12 in., the foundation stops of the great and swell being on a 6 in. wind, with the reeds raised to 8 in. in the treble. The "tromba" in the solo organ will be on a 12 in. pressure, and the rest of the solo organ 8 in. Instead of the usual English system of composition pedals for drawing out and putting in groups of stops to produce different combinations, the continental "Ventil" system was adopted as on the whole best for such an instrument, balancing advantages and disadvantages, and has been retained. Under this arrangement the great organ soundboard is subdivided into four sections, each containing its own group of stops, and by means of four pedals either left up in their normal position or "hitched down," the wind is either cut off from or admitted to each department by the "ventil." The manual organs as well as the pedal organ are similarly treated.

It may be remarked, as a matter of comparison, that Messrs. Gray & Davison's celebrated organ in the Leeds Town Hall, erected in 1859, has 94 sounding stops and 17 couplers, etc. It is expected that the Crystal Palace organ will be re-opened early in the present summer. Mr. Alfred J. Eyre is the Crystal Palace organist, and his reputation is a sufficient guarantee that full justice will be done to Messrs. Gray & Davison's noble instrument.—*The Engineer.*

COUNTRY HOUSE, COSTING $600 TO $800.

(COST AS HERE DESCRIBED, $700.)

By A. C. SWARTZ, Girard, Kan.

The envelope "motto" that designated this plan was: "Poor Man's Dwelling." Mr. Swartz, who claims to be a

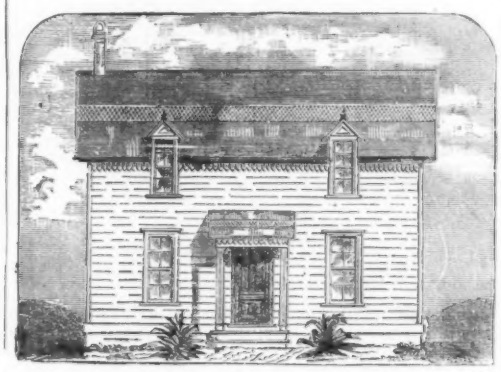


FIG. 1.—FRONT ELEVATION.

"practical farmer," took the first prize in the second class, for a dwelling costing $1,900, which was described in the *American Agriculturist* for April last. The estimates for this house, as given below, make the complete cost just $700. To the elevation plans, as received, we have added some ornamentation, such as laying part of the shingles out of the uniform plain courses; putting the perpendicular pieces

FIG. 2.—SIDE ELEVATION.

with rounded ends upon the cornices, and a few extra mouldings and trimmings. The additional cost of all these will not exceed $20, or at most $25, but they very greatly increase the beauty of the architectural appearance, we think. It is an almost universal fault with at least nine-tenths of all our present country houses, that they have the plainest possible outlines, and no effort is made to give variety, which can be

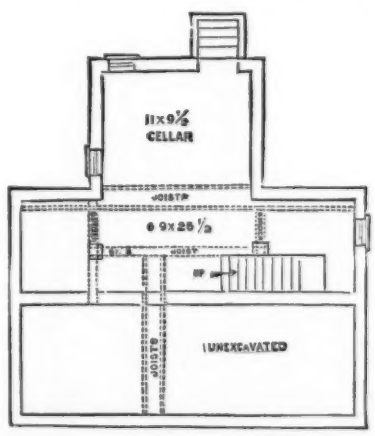


FIG. 3.—CELLAR OR BASEMENT.

done at very trifling cost. Simply using a few feet more of lumber to enlarge the size of the outside caps and casings of the windows, would materially improve the looks of a great many plain houses. A neat, tasteful dwelling can be constructed at about the same expense as one without any character of its own. Twenty-five to fifty dollars extra on the house itself, with as much more on the surroundings—the grounds and fences—may be so expended as to raise the

salable value of a farm many hundreds of dollars. It is important, however, to avoid putting on finical, fanciful ornamentation which is without any special design or harmony, and often offensive to the eye. The judges, in selecting this plan for the second prize, on account of the general convenience of the internal arrangements and other features, appended to their award the following criticism, which is an important one: "A house of this cost—indeed, every house—should have some kind of an entry hall to break the force of winds, and not allow them to directly penetrate the living room whenever the outside door is opened. The engravings showing the front and side elevations and the cellar, and first and second story floor plan, together with the de-

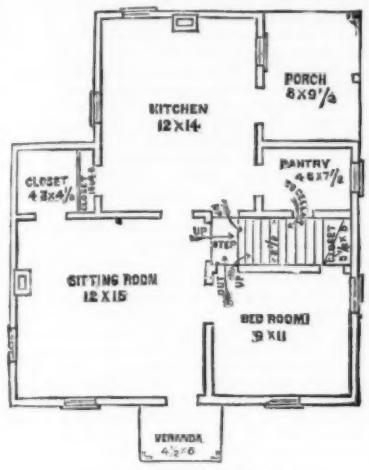


FIG. 4.—FIRST FLOOR.

tailed account of the timber and lumber required, give sufficiently full information to the ordinary builder or carpenter to enable him to construct the whole house, and we need not give much space to a minute description. The elevations (Figs. 1 and 2) show that little expense is needed for outside ornaments, as the aim is to adapt the cost to those having very moderate means. Every one constructing a house on this general plan will, of course, with the aid of the carpenter, make any desired modifications in the simple parts that constitute the chief ornamentation. In this, as in all other country house plans, we recommend the addition of a covered veranda along one side, if not on two sides, whenever the small additional expense can possibly be afforded. The outside covering is of inch boards, put on horizontally, planed

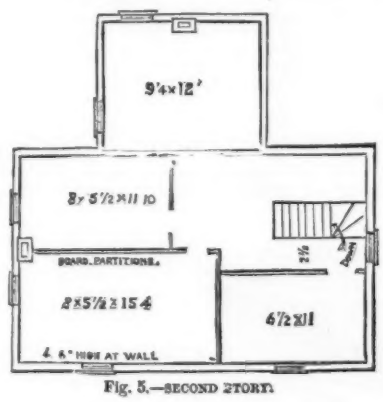


Fig. 5.—SECOND STORY.

outside. The jointing is not specified. We suppose it to be the "Novelty Siding" (Fig. 6). The estimates provide for no sheathing under the boarding, of tarred or roofing paper. This should never be omitted, and the cost for a house of this size is only a few dollars.

Basement, or Cellar (Fig. 3). A part of this is left unexcavated. This can be done at any subsequent time, but the old advice given by a farmer to his sons, "Always make your cellar as large as your house," is useful. The cellar room here provided may be ample on a new farm, where only grain and grass will be grown at first, but plenty of cellar room is always handy. A dry cellar under a house conduces to healthfulness. It is always best to place the first floor 2, 3, or 4 feet above the general ground surface, and use the

FIG. 6.—NOVELTY SIDING.

cellar earth, and more if needed, to bank up against the walls in very cold localities, and always to have the ground graded downward from the house outward, so as to quickly convey falling rain away. If the cellar walls are warm enough to keep out frost, it is better to have them extend at least two feet above the graded earth, that windows may admit light to the cellar. If necessary, a temporary banking-up against the walls in winter may be provided in autumn and be removed in spring.

First Story (Fig. 4). Height, 8½ feet. The plan is considered a convenient one. Mr. Swartz writes: ". . . If a fire is desired in the first story bed-room, let the entrance and the window at its left change places; change the position of the door to the bed-room, and move the chimney over to the wall separating the sitting-room and bed-room, with a fire-place or stove-pipe entrance on each side." . . . "The entrance from the bed-room to the stairway can be omitted, but is very convenient especially in case of sickness. . . ." [It will be noticed that the three doors at the foot of the stairs afford a private passageway from any one room to another, and also from any room to the chamber.] . . "The kitchen closet can be arranged as a bath-room, if desired. . . ." This closet can be spared, as there is a fair-sized pantry; but a part at least of the sitting-room closet would be required to make the bath-room large enough, unless it extended a little into the corner of the kitchen. The specifications and the estimates of cost call for three-coat plastering of the first story rooms.

Second Story (Fig. 5). The height of the rooms along the outside walls is 4½ feet. "The partition walls are board or plank, and the rooms are ceiled throughout. . . ." There are four bed-rooms, with a large space around the stairs for storage which may be utilized for a temporary bed on extra occasions, as when there may be additional help employed at harvest time. The smaller front room cannot be warmed. If the change of chimney, noted above, be made to heat the lower bed-room, this upper room and the larger front one can each have a small stove; the rear main story bed-room can be warmed, if needed, by carrying a stove-pipe through the partition to the rear chimney.

COST.—"The materials and workmanship are to be first-class; the finishing plain throughout. Common labor is reckoned at $1 to $1.25 per day; skilled labor $1.50 to $2.00." Labor is now higher than these figures in most parts of the country.

ESTIMATES OF MATERIALS.

Sills, Girders, Posts.

2 pieces, 6x6 in. x 14 ft.	84 ft.
2 pieces, 6x8 in. x 14 ft.	112 ft.
1 piece, 6x8 in. x 15 ft.	60 ft.
1 piece, 6x8 in. x 16 ft.	64 ft.
4 pieces, 6x8 in. x 18 ft.	288 ft.
	608 ft.

Studding, Rafters, etc.

54 pieces, 2x4 in. x 9 ft.	324 ft.
4 pieces, 2x4 in. x 10 ft.	27 ft.
34 pieces, 2x4 in. x 12 ft.	272 ft.
48 pieces, 2x4 in. x 14 ft.	448 ft.
25 pieces, 2x4 in. x 16 ft.	167 ft.
6 pieces, 2x4 in. x 18 ft.	72 ft.
7 pieces, 2x4 in. x 20 ft.	93 ft.
	1,403 ft.

JOISTS.

8 pieces, 2x8 in. x 8 ft.	85 ft.
15 pieces, 2x8 in. x 10 ft.	200 ft.
28 pieces, 2x8 in. x 13 ft.	485 ft.
8 pieces, 2x8 in. x 15 ft.	160 ft.
	930 ft.

Total, 2,941 feet, @ $22 per 1,000 ft.	$64.80
250 feet of 2 inch plank, @ $25.00.	6.25
800 feet of 1-inch boards, @ $30.00.	24.00
700 feet of 1-inch boards, @ $22.00.	15.40
300 feet of 1-inch boards, @ $20.00.	6.00
Shingling, lath, and cellar beams, 103 pieces, 1x4 in. x 16 ft., 550 feet, @ $18 per M.	9.90
Flooring, 1,250 feet, @ $27.50 per M.	34.38
Board partitions, 384 feet, @ $23.50 per M.	9.02
Ceiling boards (three-eighths-inch), 1,330 feet, @ $20 per M.	26.60
Shingles, 9,000, @ $2 85 per M	25.65
Weather boarding, 1,540 feet, @ $22.00.	33.88
3 sashes for cellar, @ 60 cents each.	1.80
15 window sashes, @ $1.80 each.	27.00
2 outside doors, @ $2 each.	4.00
3 doors, @ $1.50 each.	4.50
7 doors, @ $1 each.	7.00
4 batten doors, @ 85 cents each.	3.40
Cellar doors	2.00
73 yards excavation, @ 18 cents.	13.14
738 feet stone work, @ 6 cents.	44.28
1,100 bricks in chimneys, @ $11.50.	12 65
187 yards plastering, complete, @ 25 cents.	46.75

HARDWARE, ETC.

Two mortise locks, $2.00; 2 mortise locks, $1 60; 12 rim locks, $3.60; 300 pounds nails, $15.00; 64 feet spouting, $6.40; 5 pairs hinges, 90 cents; 12 pairs hangers, $1.50; 2 pairs strap hinges, 30 cents; 6 pairs strap hinges, 50 cents; wire screen for pantry, 95 cents; 2 cupboard door springs, 20 cents; 3 dozen clothes hooks, 90 cents	33.85
Painting, $60; carpenter work, $150.00	210.00
Sundry incidentals	33.75
Cost of building, complete	$700.00

—*Amer. Agriculturist.*

GOLD WIRE.

IN the London *Daily Advertiser* of February 6, 1753, is an article by a contributor styled "The Inspector," who had evidently been at great pains to compass the mystery of gold and silver wire drawing, this being the primary operation in the production of gold and silver thread. This writer speaks of having made "an inquiry on the occasion of that preference which is given, not only in England, but throughout Europe, to the laces and brocades of France." He considers that this is due, at the time when he writes, in a great measure to the encouragement given in France to men of scientific ability to devote themselves to the improvement of manufactures. "In Paris," he says, "there is a Royal Society; all the men of ability are of it, and scarce any others. The most considerable part of these are paid by their sovereign for directing their talents to useful purposes; and what he has given in pensions they have repaid in the improvement of his commerce. It is to these," continues the writer, "France owes its superiority in many articles of the manufactures, and in none more than this"—namely, the production of gold thread. The perforated plates through which the precious metal was drawn into the form of wire were made of a "mixt metal," the composition of which was a secret, and so much importance was attached to the specialty thus obtained, that the exportation of these large plates from France was made a capital offense. "But," says the writer already quoted, "as we can draw no wire without these plates, we find means to procure them." Yet even when the French plates were obtained the problem was not solved, for we find it stated that "the difficulty is the use their inventors made of them."

Looking back to the state of things which thus existed a hundred and thirty years ago, it is satisfactory to find that London is now able to compete successfully with Paris and Lyons in the production of the wire and the thread which once remained a special art with the continental cities. As descriptive of the present state of this manufacture in England, we will take one factory by way of example. Something of reservation and mystery still appears to surround this industry. The establishment of which we speak is one which may not be entered by everybody, and by no means cares to proclaim its precise character. In a quiet and secluded spot, yet only about five miles from London Bridge, is a quaint-looking structure, partly brick and partly timber, which, according to its appearance, might be taken for a paper-mill, and yet is nothing of the kind. It stands in the midst of pleasant grounds, with a broad sheet of water, some acres in extent, spread out before it, and with a stream running through it which serves to drive a mill-wheel, thereby setting in motion a number of machines inside, which, as a general rule, bear a strong resemblance to the machinery of a cotton-mill. But the establishment, though of no great size, aspires to a higher dignity than that of cotton. The history of the locality has been traced back to the time of James I., and it seems at a somewhat early period to have been used as a species of armory, where small arms were manufactured in connection with the crown. The water-power made it valuable for this purpose; but at length it underwent a change, and became the site of a flour-mill. About the year 1810, owing to the high price charged at Birmingham for the supply of "Brown Bess," the power of the mill-wheel was once more employed in the manufacture of small arms, and the place became a species of Enfield factory in embryo. So matters continued until 1819, when the "Armory Mill," with all its surroundings, was put up for sale as "freehold government property," by order of his Majesty's Honorable Board of Ordnance, from which period it passed into private hands. The early history of the place has left its mark in the semi-official aspect which still clings to it. Where the water does not serve as a check against intrusion, the area surrounding the building is encircled by a venerable brick wall, stout and high, communication with the outer world being effected by means of massive gates, duly flanked by sturdy cannon posts. The place might well pass for some out-lying department of Woolwich Arsenal, minus the din and smoke of that warlike congeries of factories. But the manufacturing department occupies only part of the area within the walls, and hence we meet with the tasteful surroundings of trees, shrubs, flowers, lawn, and waterfall—an attractive scene in the days of summer. Soon after the departure of "Brown Bess," a fresh name was given to the spot—that of the Silk Mills, by which it is generally known in the present day. But the title is, in a great measure, a misnomer, and was designedly adopted to hide the fact that something more precious than silk was to be found within the precincts of the old armory.

Here, then, is carried on the manufacture of gold and silver thread, including the preliminary process of wire-drawing, and various subsequent operations connected with the industry. The foundation of the whole consists of three leading processes. First, there is the drawing of the metal into the form of wire; secondly, this rounded wire has to be flattened into a tape-like form, but extremely minute; and, thirdly, there is the spinning of the flattened wire round silk so as to form the thread. In carrying out the various mechanical operations, use is made not only of the antiquated water-power, but also of the ready aid of two steam-engines. There is likewise a steam-hammer, but not such as would serve to manufacture a Woolwich "infant." The staff employed is of moderate extent, some hundred and fifty hands being engaged on the premises, chiefly females. Changes are rare, strikes are unknown, and the proprietor resides on the spot, in a tasteful dwelling which may be designated a waterside villa. Here, encircled by the old armory walls and his own "silver streak," he might almost stand a siege with impunity, drawing ample supplies of food and water from within his own domain. At first it might appear strange that there should be any connection between this homely spot and the scenes of barbaric splendor in the far East. But it is even so, and the connecting link is simply the gold and silver thread of which mention has been made. The visitor to the India Museum at South Kensington would hardly be prepared for what is a possible circumstance, that some of the exquisite brocades and other costly garments which there display their magnificence owe their interwoven or interworked threads of gold and silver to the skill and industry enshrined in the unobtrusive little factory to which we have adverted. The actual coincidence may be wanting; but as a matter of fact there may be seen at this mill little heaps of what appear to be skeins of floss silk decked with the richest tints of gold, but which in reality consist of gold thread spun to great fineness. These precious skeins are exported to India, to be used in the manufacture of those gorgeous muslins and other articles of resplendent attire in which Oriental taste delights. Machinery is thus enabled to compete with even the cheap labor of the Hindoos.

The means employed to produce these results are peculiarly interesting. In the first place, slabs or "cakes" of pure silver, weighing about a thousand troy ounces, are obtained from the Bank of England. These, after coming to the mill, are alloyed with nine or ten per cent. of copper, not for the sake of adulteration, but to make the metal sufficiently tough to undergo the process of drawing. This admixture of copper in the silver is also said to produce an effect on the gold with which it is afterward overlaid, making the tint somewhat richer than it would be if pure silver were employed. The silver thus alloyed is cast into cylindrical ingots, or bars, about two feet in length by two inches in diameter, and weighing some four hundred ounces. Each bar is then well hammered at a dull red heat, to give it further toughness. Being thus made full of hammer marks, the bar is drawn through holes in steel-plates, in order to make the surface somewhat smooth. After that it is scraped with a tool, filed, and rubbed, the entire process removing something like fourteen ounces of metal. The silver bar is now about three and a half feet in length, or nearly double what it was before, and, of course, is proportionately thinner, a result due to the powerful stretching it received in passing through the steel-plate. At this stage the gold comes upon the scene. This metal arrives at the mill in the form of leaves, but of much stouter substance than that which is employed in gilding wood. The metal is absolutely pure and very soft. With due precautions, so that no grease or moisture shall interpose, the gold-leaf is laid upon the silver bar, and leaf laid upon leaf until the requisite thickness is obtained. The gold adheres to the silver with singular readiness, and also the gold leaves at

once attach themselves to each other under the simple pressure given by the bar as it rolls over on the leaves. So quick is the adhesion that if one leaf too many gets laid upon the roll the mistake is past remedy, except by scraping all off and beginning again. The gold thus laid upon the silver generally bears to the latter a proportion of about two per cent. Paper is now wound round the bar, so as entirely to cover the metal, and this is tied up with string, in which state the whole affair is thrust into a fire of charcoal, where it remains until the cross section at the end of the bar is seen to be of a dull red heat. It is then taken out and fixed between two "standards," resembling vises in their action. Thus firmly held, the bar is well rubbed with "burnishers," and finally it is ready to be drawn into wire.

The gold which now covers the bar or rod maintains its external position to whatever degree of fineness the wire is afterward drawn. Lubrication is employed throughout, in the form of beeswax, and great care has to be exercised that there shall be no abrasion of gold. But with skill and proper appliances the gold remains uninjured. At first considerable force has to be employed, and the operation rather resembles rope-making than the production of an article which may enter into the structure of a muslin scarf. The illusion is rendered almost perfect when a couple of sturdy workmen exert their strength to wind the golden strand round a wooden windlass. It seems rough treatment for precious metals, but the subsequent stages are more delicate. We may trace the bar from its cable-like condition, through the various degrees of fineness imposed upon it as it passes through plates finer and yet finer in their proportions, until steel will no longer answer the purpose, and perforated rubies, sapphires, and diamonds have to be employed. The bar, two inches thick and two feet in length, thus becomes a wire so fine in its structure that every ounce of its weight is drawn out to the length of 1.300 yards, or from that up to 2,500 yards. Still it is "gold wire," for the silver is thoroughly encompassed by the gold. The number of holes passed through in the various gradations will be from one hundred to one hundred and fifty, and the loss of metal will not be more than from six to eight grains per troy pound. Gold wire has been drawn at this mill to the fineness of five thousand yards per ounce troy, or finer than human hair. It is possible to attenuate gold to a much greater degree than this; but it is not easy to obtain a correctly circular aperture through which to draw it. It may take a fortnight to produce a fine and true aperture in a diamond.

PLATE GLASS MANUFACTURE.

THE materials from which plate glass is made, and the proportions used, are generally kept secret by manufacturers, but the following is one of the formulas generally employed: Silica 78 parts; potash 2; soda 13; lime 5; alumina 2.

The materials, in the comminuted form, are fused in crucibles or pots exposed to an intense heat in a furnace; the complete fusion requires about 20 hours. From the pots it is ladled into a cistern, the *cuvette*, which is also placed in a hot furnace, where it remains until the glass is fired and in proper condition to flow readily and equably. When this occurs, the cuvette is lifted out of the furnace by means of tongs and hoisted on to a carriage by which it is moved to the casting table. It is now skimmed to remove impurities from its surface, and hoisted by a crane immediately over the casting table.

The casting table is surrounded by side and end ledges, corresponding in depth to the thickness of the plate to be made, to prevent the escape of the liquefied glass which is poured upon it by tilting the cuvette. During the pouring a washer is drawn immediately in front of the glass to remove any dirt from the casting slab, and when this has been covered to the requisite depth, a heavy copper roller is passed over the surface of the glass, causing it to exhibit a beautiful iridescent play of colors; this roller flattens its upper surface and causes an excess of the metal to be thrown off at the end of the table, where it is received in a trough of water.

A thick flange of the glass is turned up at the end of the plate, to which, when somewhat hardened, a rake shaped iron is applied, by which it is forced into the annealing oven, or upon a carriage by which it is conveyed to the oven. As the plate is yet plastic, its underside takes an impression from the bricks of the oven, while its upper surface, though smooth, is uneven; it consequently requires to be ground and polished. After remaining in the oven about five days, and being allowed to cool gradually, it is carefully examined to see if it will admit of being finished as a single plate, or whether it has flaws or knots which necessitate its being cut into smaller pieces. If the latter be the case the defective portions are cut out and the remainder serves for plates of less size.

In either case the plates are embedded in plaster of Paris, upon stone tables about 8x15 feet in width and length; these are arranged in pairs, at about ten feet distance apart.

Other plates of glass are cemented to the under surfaces of the two swing-tables or runners, which, by means of a horizontal frame between each, are caused to traverse backward and forward, a circular motion being at the same time imparted by means of a vertical crank shaft pivoted to the central and upper part of the table and actuated by bevel gearing; four other cranks, one at each corner of the frame, serve to guide and limit its motion, causing its central point to describe a circle about four feet in diameter, so that different portions of the faces of the upper and lower glass plates are continually applied to each other. Sharp river sand sifted into two different sizes is used as an abradant; when the surface of the lower plate has been ground quite flat by the coarser sand, it is removed by careful washing and the finer sand is substituted for it; to this succeeds emery powder, a coarser and then a finer quality being applied, the glass being thoroughly washed previous to each change of material, so that none of the coarser particles previously used may remain to cause scratches on its surface. The plates are then inverted and the same process is repeated on the other side. For this purpose the frame above described is suspended by chains, which admit of its being raised from the surface of the lower table. These machines do not permit the use of very fine emery, as their weight and velocity at such near proximity as they would necessarily be would tear the surface of the glass; the velocity is consequently reduced when the finer emery is employed, and a different machine, worked by hand-power, is used for the final smoothing, preparatory to the process of polishing. This is effected upon stone benches about two feet high, having plane upper surfaces, which are covered with wet canvas. Upon this one of the larger plates is laid, the wetted surface of the canvas serving to retain it in place. A smaller plate is used as a grinder or runner; if this be of such a size that a uniform pressure cannot be imparted to it by hand, leaden weights are distributed over its surface. Emery powders, of gradually increasing fineness, are applied with water, and the runner is traversed back and forth by hand with a semicircular stroke, its path being slightly changed at each stroke, while the runner itself is gradually turned around as on an axis during the progress of the work. These combined movements serve to evenly distribute the emery and insure an equal amount of grinding both to the bed plate and runner. Small plates are smoothed by young girls; for the larger sizes two women stand, one on each side of the bench, and by placing their outstretched hands on the runner give it a backward and forward movement of five or six feet.

About six sizes of carefully washed emery are used in smoothing, and between each change the plates and everything about the apparatus are carefully washed, including the hands of the operators. The fine emery powder last employed imparts a very smooth surface to the plates, which are now ready for polishing. The polishing machine has a bed mounted upon rollers, and traversed slowly back and forth sideways by a rack and pinion beneath. Two carriages supported on wheels at each end, which run on rails at each end of the table, have a reciprocation of about two feet by means of two opposed cranks, so that one advances as the other recedes. They are placed about four feet apart, and to their under surfaces are attached rubbers having sockets in their upper parts, into which bars with rounded ends on the under side of the carriage are fitted, allowing a certain freedom of motion independent each of the other; they measure 6x8 inches, are placed at distances of one foot apart, and their faces are covered with thick felt. By the reciprocation motion of the carriage and the transverse movement of the bed, they are caused to act on every part of the surface of the glass, a sufficient pressure being imparted to each by weights.

The powder generally employed in polishing is "Venetian pink," a substance containing a small proportion of oxide of iron mingled with earthy matter. It is used with water, which reduces the friction and prevents the glass from becoming heated. Tripoli, crocus, and putty powders when used with water cut too actively to produce a high polish in this way; though they are employed dry for the last finish in hand polishing, the amount of surface acted on with the velocity and power of the machinery would render these liable to tear the face of the glass, besides exposing it to the contingency of being broken by the heat evolved.

Repolishing old plates which have been scratched is generally effected by hand, as the operation may be restricted to the scratched portion. The process is commenced with tripoli and finished with putty powder or crocus. The rubber is attached to the end of a pole suspended from a spring, which affords the necessary pressure, and is pushed back and forth by a workman. This process is both tedious and laborious, and causes the surface to present a wavy and polished appearance much inferior to that of machine polished glass.—*Glassware Reporter.*

THE WASHING OF CLAYS.

CLAY, when stirred up in water, will remain in suspension a long time, while sand, gravel, and nodules and grains of iron pyrites will settle speedily. The finer the clay is the longer it will remain suspended in water. Advantage is taken of this property in washing the clays and freeing them from impurities. Washing has this further advantage, it brings the clay to a uniform tint or color. As taken from the bank or pit it may be streaked with brown, or yellow, or red colors, or with all of these, but after passing through the washing process these colors are all blended into one uniform tint. And by a proper selection of the white and stained clays, a great variety of colors are produced.

The apparatus for washing at one of the largest clay works consists of large troughs or bins in which the clay from the banks is deposited, covered with water, and allowed to stand for twenty-four hours. Other large troughs, in which long horizontal shafts, armed with knives, revolve, receive the clay. The knives are set at right angles to the shafts, and are fastened in a spiral line, so that at every revolution of the shaft the clay in the whole length of the trough is thoroughly stirred up and mixed with the water, which is constantly streaming into it. Large vats are used, in which to receive the clay and water. These vats are made of puddled clay at the bottom, which is then covered with boards; the sides are made of a durable casing of boards, filled in with puddled clay between the boards and backed up with earth. They are nearly five feet deep, and they cover about an acre and a half of surface. There are a number of vats entirely separate from one another, which are intended for white clays and different shades of colored clays. Each vat also has partitions or grinding boards in it, which are so arranged as to cause the water, with suspended clay in it, to circulate between them and across the vat repeatedly before it reaches the farthest part, and so that the clay may have time to settle and let the water run off clear at last. Some of the vats are low enough to be filled through troughs, which run from the washers directly to them; while others, on higher ground, have to be filled by pumping up the clay and water together, from the washing machine, and running it off through elevated troughs to the proper vats.

When the washing machine is in operation a constant stream of water is run into it and is thoroughly mixed up with the clay, which is thus divided into its finest particles and separated from its heavy impurities, and only that which is fine and completely suspended in the water can run off into the settling vats. The process of washing any desired quality of clay is carried on from day to day, till the deposit in the vat is thick enough to handle conveniently and to furnish a supply adequate to the demand.

The operation is a very complete and satisfactory one. It improves the quality of the white clays, and indeed of all the clays washed. It makes salable those which would otherwise be worthless. And it brings those which in their natural state are unsightly, to soft, pleasing, and even beautiful shades of color.

The removal of sand, pyrite, or other mineral masses from clay, by washing, is easy and effectual. The removal of oxide of iron, which discolors the clay, is attended with more difficulty, as washing does not take it out. The treatment of such clays with hydrochloric acid has been tried in Europe and found effective in removing both oxide of iron and lime from them. A practical method of using this method to obtain good fire clay from inferior and common clay is given as follows in the *Oesterreiche Zeitung*, by Kerpely: "Clays containing lime and iron are stirred with boiling water, the latter being poured on till it is eight or ten inches deep above the clayey mass. To this is added hydrochloric acid to the extent of two per cent. of the clay. After further agitation it is allowed to stand for some hours and then the acidulated water is conducted to a second vessel to which more acid is added. The clay mass is well washed with hot water, and is thrown upon a linen filter stretched over the waste ditch. In four washing troughs it is possible to clean 100 centners (five tons) of clay, for which the cost amounts to 5-5·80 florins ($4.30)."

The washing of clay is common in all kaolin districts where clay for ware or paper are obtained, and also at potteries as a further preparation for their use in the body of the finest white ware. These modes involve various styles of machinery whereby the clay or kaolin is agitated with water and then the clayey liquid is conveyed to a series of settling vats. The simplest form of a washer or agitator consists of an inclined trough in which a cylinder, set with spiral rows of knives or cutters, revolves, and by the movement of its knives pushes the mass from the feeding end up the incline and out at the opposite end. There may be many modifications in the mechanical arrangement of these appliances for stirring the clay, as well as differences in the sizes and forms of the vats. The washed clay is allowed to dry in the vats on long exposure, or the water is pressed out of it by subjecting it to great pressure in bags. The latter method obviates the length of time requisite for drying in the open air, and does not need such large vats.—*Pottery and Glass Reporter.*

LOCHMANN'S IMPROVED ATOMIZER.

THIS small and neat apparatus consists of a miniature steam boiler held between a series of standards resting on a base carrying a small alcohol lamp or gas-burner directly below the boiler. A flat bowl is supported by the standards directly above the boiler, from which a tube passes through the bottom of the flat bowl into the steam jet atomizer, which is mounted to rotate within the bowl. The steam rushes from the boiler into the rotating atomizer, and produces a powerful suction in the atomizer-tube, the lower end of which extends into the liquid to be atomized, contained in the bowl. This liquid is converted into fine spray, which is forced from the apertured arms of the atomizer with the steam. As the pressure of the steam rotates the atomizer, the spray and steam are scattered or thrown about in the room. Pure water perfumery, disinfectants, chemicals, or medicines can thus be atomized, and the air in the room impregnated therewith, whereby the air is refreshed and purified. This apparatus is very compact, and as the annexed cut shows, can be made very ornamental.

LOCHMANN'S IMPROVED ATOMIZER.

THE LAST NEW DEVELOPER.

By W. T. WILKINSON.

EXPERIMENTALISTS, amateurs, and manufacturers are chiefly interested in the various discussions upon the improvement of gelatine emulsions and drying-cupboards, etc ; but the majority of professional photographers are chiefly interested in the best method of development. Up to about two years ago the pyrogallic acid was used dry, and either weighed out in small quantities, or guessed at, until Mr. B. J. Edwards introduced his formula containing glycerine, among the many advantages of which was, that for the first time it was possible to dispense with the waste of time and pyrogallic involved in weighing, and the uncertainty in guessing; and, at the same time, to depend upon the solution of pyrogallic keeping in good condition for any length of time (in reason).

Advantageous as Mr. Edwards' glycerine formula was in many respects, the danger and risk of air-bubbles so easily formed when a colloid body, such as glycerine, is present, was introduced. The publication of Mr. Cowan's formula, wherein citric acid was used as a preservative, was a great improvement, and Mr. Cowell's process of clearing the pyrogallic-stained shadows by immersion in a mixture of citric acid and alum seemed to promise the acme of perfection, as, with the expenditure of a little extra care and trouble, negatives could be obtained of the best quality, and free from the objectionable yellow stain in the shadows almost inseparable from alkaline pyrogallic development.

No sooner, however, were photographers settling down to this tedious but necessary method of getting good negatives, than Mr. Berkeley re-introduces a process advocated by him eighteen months ago, offering the many advantages of absolute certainty in the keeping quality of the pyrogallic solution, the greatly improved brilliancy of the negative image, and the entire freedom from yellow or other pyrogallic stains, as well as—especially when a large quantity of negatives are developed in a batch—great economy in the quantity of pyrogallic used; and I venture to predict that, at no distant date, this formula will be the universal one.

The formulæ that I find best for portrait and general commercial work are as follows:

No. 1.

Sulphite of soda	4 ounces.
Water	40 ounces.

Dissolve; then add sufficient of a saturated solution of citric acid to produce a slight acid reaction upon litmus paper; now add one ounce of pyrogallic, and make up bulk to 54 ounces with water. This gives a solution each ounce of which will contain about eight grains of pyrogallic.

No. 2.

Ammonia 0·880	1 ounce.
Bromide*	180 grains.
Water	40 ounces.

Equal parts of this will give a four-grain pyrogallic solution, a strength which is a good average. This developer will be found all that its author claims for it—viz , simple and perfect. In my hands I can get a good negative out of a plate, no matter what is the exposure (in reason). If, upon applying the developer, it is found that the exposure has been too short, wash the plates thoroughly, flood with ammonia-bromide solution, and allow it to act for three or four minutes, when the details will gradually develop, without, however, gathering density, which is easily obtained by returning the plate to the ordinary pyrogallic and ammonia-bromide mixture. When all the details are out by the method, there is immense latitude, and no danger of getting the hard negatives so characteristic of under exposed gelatine plates. On the other hand, in case of over-exposure, stop the development, wash thoroughly, and immerse in a mixture of pyrogallic solution 4 parts, ammonia-bromide ½ or 1 part, and, instead of the ordinary flat and thin negative, useless for anything (except smashing), a good negative is obtained, only very thick and slow in printing, but yielding good vigorous prints.

If a batch of plates are to be developed, the same solution will do for them all, merely adding a little more now and again of No. 2 to replenish the ammonia that has evaporated.

Negatives possessing the color and characteristics of wet collodion negatives are obtained by first of all soaking the plate in No. 2 solution for one or two minutes; then pour off, and apply the half-and-half mixture of Nos. 1 and 2. This plan also is strongly recommended, when the exposure is either known or guessed to be short.—*Photographic News.*

* Of course the bromide must be altered to suit the particular make of plate used, as recommended by the maker.

ON THE INTENSIFICATION OF NEGATIVES.

THE question of the most reliable mode of intensifying gelatine negatives is certainly a most important one from several points of view. The primary object to be aimed at is to obtain a negative capable of yielding, by the ordinary printing process, a picture in all its details of light and shade. And the considerations which should guide us in an endeavor to attain this desirable end should, if possible, be by such means as shall combine the best guarantee of permanency of image along with efficiency, while, in other respects, the operation should be one which does not necessitate a large amount of skilled labor nor of many chemical appliances. In my own operations, which for some time have been little more than experimental, I have altogether discarded the use of intensifiers which act chemically, by converting the already-formed image into a denser or less diactinic silver compound. The mercurial mode of intensification may be taken as a type of these; but at the best, so far as my experience goes, the results are far from satisfactory, and these same mercurial or otherwise converted images possess, in my hands at least, the unhappy knack of going all wrong after they have been printed from for some time. In fact I could not now put my hand on a mercury-intensified negative which has not lost a large proportion of its originally good printing properties by frequent exposure to light in the printing frame.

But my experience with silver-intensified negatives is entirely different. They, as yet, have behaved quite as well as negatives on wet or dry collodion films; in other words, with fair treatment they have remained nearly as perfect as they were originally. One can see at a glance, from your advertising pages, that there is an immense variety of gelatino-bromide dry plates in the market, and the great probability is that some of these will vary considerably, not only in their susceptibility to receiving an actinic impression, but also in their amenity to intensification after that impression has been brought out to its fullest available extent by the first developer.

From my own experience in this matter I should unhesitatingly give the preference to intensification with acidulated silver and pyrogallol *before fixing*, whether the negative be on wet collodion or by any other process. Indeed, I have never known this method to fail provided the proper conditions be observed; yet this, like every other plan, will be in some respects unsuccessful in cases where, through over exposure the originally developed densities of the high lights and half tones have overtaken each other and present the same flatness or deficiency of contrast. Nor will silver intensification be of much avail in the opposite case of under exposure, as it cannot add a particle of fresh detail to that which has already been brought out; it can only pile up some fresh material on that which has already been formed. This and nothing more. The brush or crayon guided by artistic skill is the sole antidote for these defects. But here again one is apt to get into the indefinitely imaginative and spoil nature's chemical handiwork by ill-directed and inartistic bungling.

I dare say I may be considered old-fashioned when I state that the method which experience has taught me to be the most effective in the intensification of negatives on wet or dry plates is nearly the same for both. In the wet process, after the first development with ferrous sulphate, if the density be not considered sufficient, the usual plan of a little acidulated ferrous solution with a few drops of an acid twenty-grain solution of silver nitrate are applied till the required density is reached. This applies to portraits and landscapes. In cases of copying engravings, and in that class of work wherein it is necessary to secure absolute opacity in the high lights, intensifying with acidulated pyrogallol and silver is the most effective plan. But here, unless careful, we sometimes encounter a drawback; for if the intensification be carried too far by the piling up of reduced silver the finer lines may become obliterated, or at all events so obscured as to lose their value in the picture.

Gelatine with its complex organic constitution is a more ticklish substance to deal with chemically than the less complicated collodion. Hence we must be more careful in our mode of treating it, and be more expert in our appliances, if we desire to make it absolutely subservient to our high will and purposes. Yet that such can be done is undoubted, although the means of attaining the desired end are not always clearly evident. Besides its highly organic character there are some other peculiarities in the way which render gelatine more difficult to deal with than collodion. These arise from its mechanical, and, in some respects, its chemical constitution under different conditions of temperature and from other causes. To meet these changes by adequate safeguards against failure in any adaptation of this complex compound to our own purposes is sometimes an impracticable, and always a more or less difficult task, more especially as some of the compounds used in rendering it sensitive to light, and in the after processes of obtaining a photographic impression, alter its character to a considerable extent, and in a way which is, as yet, imperfectly understood. Nevertheless, I have never met with any difficulty in the matter with any make of good gelatine plates, provided the intensification be completed before the fixing agent is applied. When the first development is completed and the film well washed, there is no necessity for using a dull ruby light. Ordinary orange-yellow light may be admitted, by which the density of the image can be more accurately judged. The acidulated pyrogallol is first applied two or three times, mainly to counteract the effects of any trace of alkali that may remain; the silver is then added sparingly and the mixed solution poured on and off till the required density is reached. Intensification by white light, either before or after fixing, is not to be recommended, inasmuch as by its actinic influence the developer is rapidly decomposed and is apt to stain the film. Local intensification may thus be given to any portion of the picture which seems to require it, by simply pouring the solution on and off that particular spot.

Intensification by means of silver should never be conducted in a shallow or other tray, for reasons which have already been fully entered into by the editors and others. *George Dawson, M.A., in Br. Jour. of Phot.*

A NEW MERCURO CYANIDE INTENSIFYING PROCESS FOR GELATINO-BROMIDE PLATES.

By DR. J. M. EDER.

THE negative it is desired to intensify is, after fixing and thorough washing, placed in a solution of bichloride of mercury, just in the same way as in the old process.

The negative is next well rinsed with water and put into a second bath. This is made up by dissolving in 1,000 parts of water—

Cyanide of potassium	5 parts.
Iodide of potassium	2½ "
Bichloride of mercury	2½ "

The negative will then pass through three stages of change.

1st Stage.—The negative grows more dense and becomes yellowish. This is by reason of the action of the iodine salts upon the mercury. Remaining still in the bath the negative reaches—

2d Stage.—The film becomes dark brown; the negative gains enormously in vigor, and the contrasts are heightened. The reason for this is the gradual metamorphosis of the subiodide of mercury by the cyanide of potassium. In this condition the image is very vigorous. Flat negatives are by this means rendered quite brilliant, but those of normal character become, as a rule, too vigorous and too hard.

3d Stage.—If the negative is too dense, it is allowed to remain still longer in the bath. The intensity gradually diminishes, the color of the negative becomes a lighter brown, and the image is more transparent, *while at the same time none of the detail is eaten away.* The vigor slowly decreases, until at last the negative has no more density than it possessed previous to its treatment.

The changes I have detailed follow slowly. The stages remain for some minutes, and for this reason the process is easily watched and controlled. Owing to the nature of the changes, moreover, this process of intensifying may be adopted for negatives of different kinds.

This mixture of cyanide of potassium, iodide of potassium, and chloride of mercury, may also be employed as a means of reducing density. If very dense negatives (after fixing and washing), are put into it, the image becomes gradually thinner, its harmony being preserved the while. In half an hour or an hour the change will most likely have taken place. Still, although the weakening of the negative proceeds very slowly, it is better to dilute the cyanide solution with an equal volume of water.

The method I have described is a very comprehensive one; that is to say, it may be employed for improving flat negatives and hard negatives. It is more advantageous than the cyanide of silver and cyanide of potassium process, because the brown color has a more favorable result. Moreover, of this last process it is said that the negative, after much printing, becomes of a rose-red color, due to the decomposition of the residual cyanide of silver.

Finally, I may say that in the interval between the mercury bath and the cyanide bath, even when the negative is insufficiently washed, there is no chance of any spots forming on the film.—*Photo. News.*

CARL WILHELM SCHEELE.

IN the year 1782, just 100 years ago, two scientific amateurs—M. de Virly (a Frenchman) and M. d'Elluyart (a Spaniard)—made a journey together into Sweden, mainly for the purpose of visiting two chemists who had made for themselves European reputations. The one was Bergman, the other was Scheele. Bergman was the professor of chemistry at Upsala, the university of Sweden, and at that time held the undisputed pre-eminence in that noted school of learning He was then 47 years of age—a most omnivorous student. In his youth he had come under the influence of Linnæus, who had fascinated him into botanical studies, from which he branched into entomology, and won distinction in both sciences. But these studies had been but distractions to him. Mathematics had during his student days engaged all his earnest attention; meanwhile he studied law, and studied it hard, to please his father, who had sent him to Upsala for that purpose. No one knew that he had joined chemistry to his other pursuits until, on the death of Wallerius, Bergman put in a claim for the chair which was thus left vacant. He wrote some treatises for the occasion, which proved to be of value, was bitterly opposed by the chemical section, but was as ardently supported by influential friends in the university, and secured the chair, which he held to his death, to his own and to his country's glory. Bergman was omnivorous, too, in another and in not quite so creditable a sense. Chemists have detected various curious coincidences between his observations and previous ones of Black, Cavendish, and Priestley, which it is hardly supposed were accidental, while it is generally believed that he cribbed from his devoted friend and admirer, Scheele, the credit of at least one discovery, namely, that of oxalic acid, which he, Bergman, claimed as his own. Still Bergman did a wonderful amount of work of a genuine and a valuable character; he won the enthusiastic regard of those who came under his professional influence, and he was worthy of being lionized by our two friends, de Virly and d'Elluyart.

After they had duly worshiped at Bergman's shrine they set off to Koping to see Scheele. Koping was a pretty little town situated at the head of the fiord at the mouth of which Stockholm stands, some 80 or 100 miles distant from the capital. They went to the pharmacy, where they found behind the counter, with his apron on, and probably making pills, a young-looking man of unimposing aspect. They asked for Herr Scheele. The unimposing-looking young man said that was his name. What could he do for them? They produced their letter of introduction from Bergman, and soon Scheele and his visitors were deep in conversation, discussing the science and especially the chemistry of the day. And the chemistry of that epoch was of the highest interest. All the chemists in Europe were beginning to see dimly the facts which were to form the basis of modern chemistry, and which Lavoisier would in a few years make clear by adjusting the focus of the instrument through which they were observed. Scheele was an eminently practical man; his papers as a rule, record facts and discoveries, but he had himself contributed largely to making the work of Lavoisier possible. In 1777 he had published his treatise on air and fire. Priestley had anticipated him in the most important discovery there announced, namely, the separation and description of oxygen, though it is universally conceded that Scheele's researches had been quite independent of and probably anterior to those of the English chemist. The two foreigners spent a few days in Koping, and at their invitation Scheele dined with them each evening at their hotel; but dinner over he always returned to his laboratory, whither his hosts accompanied him so as to see as much of his work as possible.

At the time of this visit Scheele was 39 years of age, and had already done much of the work which was to make him famous in the annals of chemistry for all time. A very few more years only remained to him, but they were destined to be distinguished as among the most fruitful of his life. At that very time he was probably prosecuting his experiments with Prussian blue, which led to his discovery of what is still known as Scheele's acid. A little later (in 1784) he published his essay on "A Sweet Principle Obtained from Expressed Oils and Animal Fats," which he named "sugar of oil," but to which Chevreul would later give the name of "glycerine;" and in the same year he announced his discovery of "crystallized citronian acid," since called citric acid. Half a-dozen more papers of less historical importance proved his industry until 1786, the year of his death.

Scheele's father was a shopkeeper at Stralsund, at that time the capital of Swedish Pomerania, but German in character, as it afterward became in fact. Carl Wilhelm was the seventh in a family of eleven children, and was born on December 9, 1742. He went to the public school of the place, and "finished his education," as far as masters and academies were to help him, at the age of 14. An elder brother had been apprenticed to Mr. Bauch, an apothecary at Gothenburg, and had died during his term. Carl had a fancy to be a pharmacist, too, and Mr. Bauch took him. His apprenticeship lasted six years, and when it was completed Scheele stayed with his master two more years as assistant. Some little scraps of record of this important period of his life have been gathered, but they only show that he worked at his business with zeal and intelligence, studied chemistry not with ardor, but with that tranquil, untiring patience which characterized all he did through life, and gained a reputation of cheerful seriousness. "Neuman's Chemistry," which was the leading German treatise on the science, and "Kunckel's Laboratorium," were the books from which young Scheele in after life admitted to have acquired his first interest in chemical pursuits.

Leaving Gothenburg, Scheele took a situation at Malmo with a Mr. Kalstroem. There he stayed five years, still filling up all his spare time with study and experiment. In 1769 he went to Stockholm, and spent three years in the pharmacy of Mr. Scharenberg, at the sign of the Raven, in the Market-place. It is stated that Mr. Scharenberg felt some little alarm when Scheele brought the humble apparatus which he had collected during his many studious years, but Scheele's manipulative skill and conscientious attention to the details of his business soon reassured his master, and the serious assistant, whose opportunities had now come, soon became known in the scientific society of the capital.

Public and private libraries were open to him, and here Scheele's career as an author began. In 1768 a paper by him had been read to the Swedish Academy of Science, entitled "Chemical Experiments with Sal Acetoselle," which, it is supposed, suggested the discovery of oxalic acid. This paper was not printed, but in 1770 he sent to Bergman a description of a process whereby he had prepared tartaric acid. Bergman returned the manuscript to Scheele without comment, and the latter sent his paper to Retzius, who printed it in the Transactions of the Academy, and made public allusion to it as a meritorious work. The process invented by Scheele, and which subsequently led him to the discovery of citric, malic, and lactic acids, was essentially that which has always been followed, and consisted in separating, the organic acids by chalk, and afterward freeing them by means of stronger mineral acids.

In 1771 Scheele wrote an account of experiments on fluor-spar, in which for the first time the true nature of this mineral was described. His experiments were at first complicated by separating the fluoric acid in glass vessels, but he afterward corrected his early misapprehensions, and later successfully defended his conclusions against the attacks of two French critics—Bulanger and Monuet.

In 1772 he went to Upsala, where he served a Mr. Loocke. An incident soon occurred which brought him into contact with Bergman. Loocke supplied Bergman's laboratory. One day John Gottlieb Gahn, who was then studying chemistry under Bergman, and afterward himself became a noted chemist, came in the shop and Mr. Loocke spoke to him of an interesting fact which he had observed and was not able to explain. He said that when he poured vinegar on ordinary niter he got no result, but that when he poured the vinegar on niter which had previously been heated in a crucible, the niter, though apparently unchanged, was decomposed with the evolution of red fumes. Gahn was unable to explain this fact; so was Bergman, to whom he afterward spoke about it. Gahn came again to Mr. Loocke to tell him Bergman's remarks, when he met with young Scheele. The latter said he did not think it was difficult to understand; he supposed that nitric acid, like vitriolic acid, might exist in two conditions, and he judged that the application of heat reduced the nitric from the per to the sub condition; that in the latter case the acid and the alkali had a weaker affinity for each other and were then decomposed by the vinegar. Gahn was struck with this explanation; told it to Bergman, who at once said that the author must have a clear insight into the facts of chemistry, and desired to make Scheele's acquaintance. Scheele was at first rather disinclined to accept Bergman's friendship in consequence of the slight he had received from him when he had sent him his tartaric acid paper. But Bergman was determined to be friendly, and soon he and Scheele were close acquaintances, and remained on terms of close and cordial intimacy until the death of the latter in 1784. "I intend to write his life," said Scheele in Crell's "Annalen," "as I would like to make it known that, notwithstanding the interval which separated us both in years and knowledge, he permitted me to be his friend."

At Upsala Scheele's scientific activity developed wonderfully. He sent papers to the Academy of Sciences at Stockholm on benzoic acid, on the black oxide of manganese, on arsenious acid, on the composition of the air, and other subjects. In 1775 he was chosen an associate of the Academy, and was thus recognized as among the first scientific men of the kingdom.

An interesting record has been kept of an event which occurred during Scheele's residence at Upsala. The Duke of Sudermania, with Prince Henry of Prussia, visited the University, and Scheele, though not a regular student, was appointed to show them some chemical experiments. Possibly his acquaintance with German (for at the end of his days Scheele was always most familiar with that language) may have been one of the reasons for selecting him, but it is certain that the authorities had perfect confidence also in his manipulative skill.

In the year 1775 Scheele had an opportunity of taking the management of a pharmacy at Koping. The proprietor, a Mr. Pohl, or Popler, had died, and the concession belonged to his widow. But it fell to the Medical College to appoint a *provisor*, and Scheele without much difficulty qualified himself for the position by passing the necessary examination. Bergman would gladly have kept him at Upsala, and offered to get him an appointment as manager of some government works. But Scheele had no desire to relinquish his occupation, and resolved to go to Koping. Perhaps he had seen the young widow. However this might be, he seems to have soon after decided, in his quiet, patient manner, to try to win her as well as to manage her business. As proprietress of an apotheke in Sweden, where the concession is of considerable value, she was supposed to be rich, but Scheele soon found that the business was encumbered with debts. He made it a matter of honor to restore the business to solvency in the first place. This was a work of years. In 1777 the Royal College of Medicine sent him his diploma as an apothecary, and as a special mark of honor dispensed with either fees or oath. He then purchased the concession from Madame Pohl, though she still shared the house with him. His scientific investigations were always steadily prosecuted; neither love, nor business, nor society, nor delicate health could hinder him in these. He was highly esteemed in the little town where he lived, for, when the concession of the pharamacy was to be sold, and a stranger proposed to buy it, the townsmen declared they would have no other apothecary, and that if Scheele were turned out of this one they would build him another apotheke in the town in order to retain him. He prospered and built for himself a handsome house, and himself gilded the stone lion which was the sign over his shop, and, as might be expected, he did the gilding so well that it is said it has not needed renewal to this day.

He had become himself the proprietor of the pharmacy, and now, with creditable pride, he was able to offer to the lady that very position which he had at first thought of asking her to bestow. But his health was breaking. Some say that his long series of experiments with poisonous bodies had injured his constitution, and that his persistence in working in a cold laboratory brought on attacks of rheumatism.

In 1786 his years of reward, if not of rest, might have seemed to have commenced. He had gained a competent fortune, the love and respect of his neighbors and of his scientific fellow-countrymen, and an honorable reputation all over Europe. The scientific academies of Berlin, Erfurt, and Sardinia, and the Royal Society of Medicine of Paris had enrolled his name among their honorary members. It is said—but there seems to be no sufficient foundation for the story—that the King of Sweden had proposed to ennoble the eminent chemist, but that Scheele declined the honor. But Scheele's nobility needed no royal patent; little as we know of his private life, it is evident that in every position which he filled his first idea was to do his duty: even his beloved scientific researches had to give place always to the duties of his business. And now the time had come for him to assume a new position in life. On May 18, 1786, he married the lady, for whom, he had worked so long. On that same day he was stricken down with fever. Three days later he executed a will leaving to her all his little possessions; and the next day he died. He had not completed his 44th year.

The work he accomplished as a chemical discoverer is nothing short of marvelous. And it becomes more so when we remember the bare education, the limited means, and the scarcity of leisure which were at his command. He discovered, or at least isolated and described, chlorine, baryta, and oxygen. He just missed the glory of associating his name as the discoverer of the latter-named element because he did not publish his researches as soon as he made them, but his process of obtaining oxygen has been followed to the present day. To him we owe our first knowledge of the composition of the air, of ammonia, and of Prussic acid, though curiously his paper on Prussian blue does not give any indication that he suspected the poisonous nature of the acid which has been called after him. The following long list of acids were first prepared by him, namely, fluoric, molybdic, tungstic, arsenic, lactic, gallic, tartaric, oxalic, citric, and malic. To these discoveries must be added sugar of milk and glycerine, various processes in chemistry, and researches on ethers. For the last ten years of his life he received an annual grant of 100 reichsthalers from Stockholm Academy of Science toward the expenses of scientific researches—a sum equal to about £30 per annum. Most of his experiments were conducted in his shop, and it is stated by Nordenskjold that his library after his death contained only 12 books on medicine and chemistry, with a few others in Swedish, French, and German, and was valued at 26s.

Surely these briefly-narrated facts will suffice to show that of all the famous pharmacists who ever lived none more deserves to be held in honorable remembrance than he who lived at the Golden Lion in Koping.—*Chemist and Druggist.*

MANUFACTURE OF LACTIC ACID.

By CHARLES E. AVERY.

THE acids employed in the arts have been greatly cheapened and improved by chemical study. As a notable instance, allow me to call to your notice oxalic acid, at first procured from plants, afterward more cheaply by the reaction of nitric acid upon sugar, and finally with great cheapness by treating sawdust with caustic alkalies at a baking heat.

Apart from the chemical uses of the acids, as in dyeing, bleaching, metallurgy, etc., there is another set of uses, as in food and drink. In this field the industrial improvements have not been of so striking a nature, and, as a result, the food acids, citric acids, citric and tartaric, remain high in price.

Seeing that this field remained unoccupied, I was early attracted to it, and in 1873 noted down as a chance idea the substitution of acid lactates for acid tartrate of potash, which is the old familiar cream of tartar.

Practically speaking, I did nothing until 1879, when I took up the production of phosphoric acid from apatite or mineral phosphate of lime. I succeeded in making a fair acid cheaply, and was about to go further and make it chemically pure and cheaply as well, when I became aware that the first cost of materials was theoretically much larger than the first cost of materials for the production of lactic acid. Phosphoric acid was, moreover, by some considered objectionable, being a constituent of various urinary deposits. Lactic acids then became a subject of study.

In order fairly to set before you the investigation, I will re-state what most of you may know regarding lactic acid, the lactic fermentation, and the processes in use.

When milk turns sour spontaneously, the sugar of milk which it contains is converted into lactic acid, and Scheele, in 1780, first extracted lactic acid from sour milk.

Braconnet found the same acid in rice left under water to ferment, also in the juice of beet-root, which, after having undergone viscous fermentation, became sour and yielded lactic acid. He also found the acid in products of fermentation of many other vegetable infusions.

The same acid has been found in the sour water of starch factories, and in the well-known fermented cabbage or sauer-kraut.

By lactic fermentation is understood the transformation of certain sugars, such as sugar of milk and glucose, into a sirupy acid, soluble in water, under the influence of a living being classed by the eminent French chemist and microscopist, Pasteur, among the bacteria.

Messrs. Frémy and Boutron, Pelouze and Gelis, ascertained the best conditions for the production of lactic acid, and found it, they say, to require the aid of nitrogenous albuminoid matter in a state of decomposition, and for its continuance that the acidity should be kept down by neutralization. For this purpose they used oxide of zinc, carbonate of soda, or, as I prefer, the carbonate of lime, that is to say, whiting or marble dust.

Pasteur brought out the idea that the albuminoid matter was non-essential, that it could be substituted by inorganic salts, and that the real cause of the change was not decomposing albuminoids but a living ferment—establishing this latter fact which before was a conjecture.

It is substantially here that I depart from the beaten track. I find albuminoid matter, though not, scientifically speaking, essential, is essential in a technical point of view. Moreover, it is not essential nor desirable that they should be decomposing albuminoids. I prefer them as fresh and free from putrefaction as possible. As I have no putrefaction in my solutions, the manufacture is no longer a nuisance; the odor with a pure ferment is even fragrant.

To obtain this fresh albuminoid matter at no further expense, and in large quantity, I leave in the glucose solution made from the corn meal the albuminoid residue. And from this substitution I obtain the advantage of cheapness, the advantage of healthfulness, a crude product free from the products of putrefaction, and hence more easily purified; and, lastly, the fermentation takes place in three or four days, instead of requiring ten days to a month, as by other processes.

Bensch purifies his lactate of lime by extraction with water, filtration, and re-crystallization, the details at present being non-essential. The only thing worth mention is that he was able to purify his crude material. It will be seen that cane sugar is the source of his lactic acid, costing to start with eight to ten cents per pound, for any article not too dark and impure. To this sour milk and cheese are added, further increasing the expense, and the time required is a fortnight.

Considering the variability of the process, its unsavory nature and products, and the expense, it is not surprising lactic acid and the lactates have received little attention.

I find it is still a common impression among chemists that in the change of starch into glucose by the acid treatment, the transformation is very incomplete; that much of the starch remains as dextrine. This is not the case. By suitable precautions nearly all the starch should turn to glucose, and that this can be accomplished is shown by testing the solutions and residues with iodine. Neither starch nor soluble starch is shown. Then, by testing the solutions with six times their volume of alcohol, the substantial absence of dextrine may be shown.

Since we have some 70 per cent. of starch sugar in corn, and this converted into glucose will, by assimilation of water, increase in weight some ten per cent., we have as the theoretical yield of acid 77 per cent. Now, Bensch found 9 kilos of cane sugar to yield 10¼ kilos of neutral lactate of lime, and it is not surprising that a yield of 82 to 85 per cent. of neutral lactate has been found from 70 per cent. of starch, working by my process.

The process I adopt resolves itself into three portions; 1st, manufacture of solution for fermentation; 2d, the fermentation; 3d, the purification; and, lastly, there is the use of the product itself as a separate consideration.

I mix 80 to 160 lb. of oil of vitriol with 2,000 lb. cold water, and stir in 2,000 lb. ground maize; this corn meal may be from inferior corn, from corn more or less heated, soured, or otherwise changed. The average price of corn of good quality here is about one cent. per lb., and much less in the West. Inferior qualities are of less cost. The vitriol can be bought at 1¼ cents per pound by single carboy, and would cost much less if chamber acid were used and made on the spot.

I let the meal mixture stand over night, and next morning add in portions 2,000 pounds of boiling water. After boiling until the tests are satisfacory, I run the hot mixture into the fermentation tank, and neutralize with 1,000 pounds carbonate of lime, stirring well. The carbonate of lime is of course in large excess. I then add 4,000 pounds cold water, and a variable amount of lactic ferment; one or two per cent seems to answer well, although a larger quantity induces fermentation more speedily, saving perhaps half a day, but less will suffice.

In a day's time the most vigorous action ensues, the carbonic acid released from the carbonate of lime escaping in large bubbles, giving the impression that the liquor is boiling. In three or four days' time, with good lactic yeast, the mass sets into crystals of lactate of lime, resembling thick mortar. I then dissolve the lactate in hot water, filter it, crystallize, press, and purify, much as in other processes, with two contractions, however. I use animal charcoal to remove odor and color, and after acidulation, distill off the butyric acid that has been formed. By more vigorous precautions in the fermentation, I expect soon to be rid altogether of the butyric ferment, and had, indeed, already greatly reduced it, when a series of mishaps, caused partly by the cold of this unusual winter, and partly by my landlord's negligence, stopped for a time further progress. The work has now been resumed.

From experimental results already obtained on the small scale, I have reason to believe that I can reduce the waste and cost of purification, especially in the direction of animal charcoal, and experiments will speedily be resumed in this direction. I am much assisted in this search by the comparatively clean, pure, crude material with which I start, unlike the foul mass obtained by other processes of practical value. As regards the healthfulness of lactic acid there can be no doubt. Articles containing it have been sought out as food by the human race all over the world. Sour milk, buttermilk, and sauer-kraut are well known to be wholesome. Their reputation the world over is good, and they are used by laborers and peasantry as regular articles of diet. If there were any doubts, these would be dispelled when I state that lactic acid is present in the flesh itself, and in the mother's milk; that lactic acid is an active agent in the digestion of food in the stomach, and a constituent of the gastric juice. For this reason it is given medicinally for the cure of dyspepsia, as in the well-known preparation of lactopepsine.

As to the value of lactic acid and acid lactates in raising bread, as substitutes for cream of tartar, there can be no question, for sour milk always has raised bread, and made good bread, and cream of tartar is a substitute for lactic acid rather than lactic acid a substitute for it. At present prices of milk the cost is greatly reduced. The corn is not fed to the cow partly to be wasted in maintaining heat and life, and partly to be returned as fat and decomposed sugar; but by a simple change turns almost completely to lactic acid. In one respect, however, I think an advantage may be fairly claimed for the acid lactate of lime over cream of tartar, namely, it will be hard for any cook, no matter how careless, to make either sour bread or alkaline bread, and every cook has such failures with cream of tartar. In cream of tartar, or acid tartrate of potash, the acid molecule reacts on the saleratus to free the gas; unless the exact proportions be hit and the mixture be complete, the bread is alkaline wholly or in spots if the saleratus be in excess, and sour if the acid tartrate be in excess.

In the acid lactate of lime, in like manner, the acid molecule reacts to free gas from the saleratus.

The neutral lactate of lime left by the reaction again acts on the saleratus, forming lactate of soda, carbonate of lime, and free carbonic acid. Hence, we have a wide range of proportions in which the bread can be neither acid nor alkaline.

This carbonate of lime is itself a guard against acetous fermentation, or souring of the bread, and can hardly be objected to, as Liebig has recommended lime water to be used in bread-making, partly to add the lime salts taken out by bolting, partly because it improves the quality of the bread and its appearance.

Now, what has been done in this investigation? I think the specimen before you will answer for one thing—that the acid lactate is a permanent salt, not readily changed to butyrate; not deliquescent, for it was dried on my laboratory table; not too gum-like, to resist powdering.

In the next place, I have rid myself fully of the notion that starch, dextrine, and other carbo-hydrates undergo a true lactic fermentation.

In Miller and other works of good standing it is stated raw corn meal under like conditions had but partly changed lactic acid in forty days. Technically speaking, corn meal cannot furnish lactic acid unless the starch be first transformed. Nor will it then give lactic acid in quantity unless the albuminoid matter be either added or left in the presence of the nitrogenous phosphatic salts, if the neutralizer of the ferment is not a fulfillment of all the conditions for large and varied yield; we must at present have albuminoid

matter present. It has been fully shown that it is not essential that this albuminoid should be rank or putrid, but that better and quicker results were obtained with fresh vegetable albuminoids than with stale animal albuminoids. I have improved the purification by introduction of animal charcoal and distillation, and have made the operations inoffensive. With regard to cheapness, little needs to be said. With a yield of lactic acid equaling fifty per cent. of the weight of corn employed, with meal at one cent per pound, chalk or whiting at seven-eighths of a cent, and sulphuric acid at 1¾ cents, coal being assumed at $6 per ton, the cost of materials for one pound of lactic acid is about 4½ cents.

By shrewd location of the factory, and good buying in large quantities, these expenses may be largely reduced.

The operations of manufacture are not unlike those of the sugar refinery, and those are known not to be excessive. Considering the experimental and theoretical data now in hand, it seems but reasonable to expect a larger yield and a less expense after further experimental work.—*Proc. Soc. Arts, Boston.*

CURIOSITIES OF COLOR.

By HENRY J. SLACK, F.G.S., F.R.M.S.

A COUPLE of prisms will enable two spectra of the sun to be thrown upon a white ceiling, or sheet of white paper fastened to the wall. By a little management, the two spectra may be wholly or partially superposed, and the very different behavior of light rays from pigments thus displayed. The exact and coincident superposition of two similar spectra will re-enforce the colors, and if one is thus made to slide over the other, the effects of combination will by no means agree with the mixtures of analogous pigments. The red and green will give a yellow, and this result of combining red and green is also made evident by Lord Rayleigh's "New Color Combination Plates," made by Browning. In this apparatus a blue disk is superposed over a yellow one, and then, as the inventor says, "the yellow disk absorbs the blue light. The blue disk absorbs the yellow and orange light. By superposing the disks, and viewing a white object, as a cloud, the resultant light will be yellow. But on analyzing the same with a spectroscope, it is proved that yellow light is produced by a commingling of red and green, since these rays of the spectrum are alone transmitted."

The success of the experiment depends upon hitting the exact tints of the two colors. In the specimen before the writer, the yellow is rather orangy, and when examined with the spectroscope shows colors from deep-red to a blue-green. The blue disk analyzed in the same way shows a band of bright red, succeeded by a cloudy one, something like a dingy, brownish puce, and then green blue, and violet; no yellow. The combination, which gives an orangy yellow, when analyzed shows red and green, and a cloudy band in place of the orange and yellow. The blue and violet are suppressed.

Another way of making interesting experiments is by obtaining from an artists' color-shop (such as Brodie & Middleton, in Long-acre) various sheets of colored gelatine and a sheet of black cardboard. Cut some of the cardboard into four inch squares; make a round hole in the middle of each square, 1½ inches in diameter. Over these holes fasten colored gelatine of all the chief obtainable tints. This is done most usually by laying the gelatine on the unblackened side of the cardboard, and gumming over it a square paper with a hole in it corresponding with that in the cardboard. This keeps the gelatine in its place. When one of the squares so prepared is held near the eye, the black part excludes most of the diffused white light, and objects in a garden or in a room may be seen as affected by the tint of the gelatine, with a result that is often very different from what might be expected. For example, a sky-blue disk slightly blues white flowers, gives a dingy purplish hue to the rich pink of dielytra, and makes the yellow-green of aucuba leaves less noticeable. After this take a disk of purple, like the common small blue glass so often misapplied in Cockney conservatories. Many green leaves now flash out with red tints. At this moment the writer sees this effect in young April rose leaves, the lightest aucuba leaves, the golden green of *Thuja aurea*, and many more. Polyanthus and winter aconite leaves assume a dull lurid tint, while the dielytra blossoms have a richer glow. A crimson disk quite changes the bright leaves of aucuba and *Thuja aurea*. This shrub looks as if covered with orange-yellow flowers, while the sky, now covered with a pale cloud, takes the full crimson hue.

All the objects at the time of writing are in a fairly strong white daylight, and the leaves, according to their character and the angle under which they are seen, reflect more or less white light, besides exerting their normal effects of absorbing portions of the spectrum.

For another set of experiments, cut some pieces of black cardboard six inches long and four wide; punch, or cut, then, half-inch in diameter round holes. Cover one set severally with a blue, a crimson red, and a yellow piece of gelatine. Hold it up against a white cloud; look at it with a double image prism. By keeping the prism near the eye, and holding the cardboard at a suitable distance, to be found by experiment, and then rotating the prism, it is easy to make any one of the colored disks overlap any other one. Sky-blue and pale yellow thus treated give nearly white light. If the same tints of pigments were mingled, the result would be a pale green. The yellow superposed upon the crimson makes it orange. Superposing the pale blue upon the crimson gives a whitish, violetish gray, the tint varying with the quantity of white light reflected from the cloud.

Prepare another card by occupying two holes with disks of blue and yellow, each having one, and the third hole with both colors superposed. The result of this superposition is a green, as it would be with pigments, and it is interesting to compare this green with the approximate white obtained by superposing the tints by means of the double image prism. A similar card prepared with crimson and green separate, and also the two combined, are likewise instructive. The actual superposed combination of the gelatines effects an orangy modification of the crimson, but when the superposition is made by increase of the prism, yellow is the result. Other combinations by superposition and by prism should also be compared.

After the above experiments, gum three strips of white paper, about one inch long by half an inch wide, on a square of black cardboard, a little way apart. On one slip fasten (which can be done by slightly moistening) a square of blue gelatine and one of yellow beside it. Expose to full white light, and cause superposition by the prism. The tint obtained is a chocolate gray. Red and crimson thus tinted give orange; crimson and green, dark gray.

The effect of a double image prism, by dividing one colored ray into two, is to lessen its force, and the effect of adding, by reflection or transmission, a strong white light to any color is to thin it out, or completely subdue it. Stick a small square of crimson gelatine in the middle of a sky blue disk fixed in a black cardboard square; hold it against a white cloud; duplicate the image of the crimson square with the prism; such image is bluish-gray. Make portions of the two images touch; the crimson, modified by the blue, at once appears.

In studying these various effects, the exact conditions of each experiment must be noticed. Thus, dealing with spectrum colors is employing rays of light of certain refrangibilities, according to the dispersion obtained. Pigments are either opaque or transparent. The action of an opaque pigment is to absorb certain rays composing white light, and to reflect the residue. If such a pigment is seen in strong white light, the quantity thereof which it reflects acts in proportionate diminution of its normal color. In viewing gelatine pastes held up against a white cloud, the color seen is the residue left after its absorption of the rays that cannot pass through it. If one film is imposed over another, and both are held up to the light, the first film only transmits to the second the rays that remain after its absorptive powers have been exercised. If a transparent tint is superposed upon white paper, that paper reflects through it the rays which the colored film has not absorbed, and subjects them to a fresh action of the film as they pass for the second time through it.

To show what white, or approximately white light can do with a strong color, throw a full red on a white screen with a magic lantern. Then with another magic lantern, or a common bull's-eye lantern, placed nearer, and thus casting an intenser light, overpower the colored light. A hand with outspread fingers, held so as to obstruct the white light, casts a red shadow. The stoppage of the white light permits the redness to reappear. This might be used in melodrama with powerful stage effect. A black figure could be made to cast a blood-red shadow as he passed a white-looking wall. The experiment in a room with the outspread fingers is very striking. Many similar arrangements will occur to your readers, among them not the least interesting is the production of subjective tints by throwing with a lantern on a screen the images obtained by Wheatstone's superposed disks of perforated zinc. It is easy to fit in the ordinary wooden slide-holder a square of the zinc, which may be fastened to the frame, and to fix to it a circle of similar zinc, so as to rotate freely on a pin. The circle should be wide enough to project a little above the frame, and be easily reached with a finger, to make it revolve. Colored gelatine films placed close to the front lens of the lantern will give the effects required.—*Knowledge.*

SOME APPLIANCES FOR GELATINO-BROMIDE WORK.

By DR. HERMAN FOL.

THE first time I prepared my own gelatine plates, I borrowed two drying cupboards in order to dry them, but after examining these rather cumbrous apparatus, each far too large to be put in my dark room, I grew rather suspicious about their real darkness, and so began by putting a plate in each, and I left them to stand a few hours in broad daylight. After this I withdrew the plates with due precautions, and upon applying the developers found that both were considerably fogged.

My emulsion was ready, and seemed good; what was to be done? I had at hand a large zinc case with a lid of the same material, so I cut a long opening at one end of the bottom, and had another bottom soldered inside with an opening at the opposite end (see diagram). I then had a

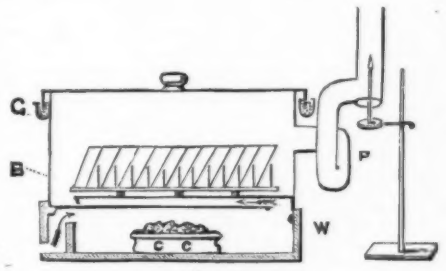


FIG. 1.

B, zinc case; G, gutter filled with small shot; W, wooden tray; CC, calcium chloride vessel; Russian chimney.

so-called Russian chimney fastened on one of the sides, and fitted this with a gas-flame placed as shown, so that it might produce the necessary current of air. To make the cover fit air and light tight was rather more difficult. This, however, I managed in the following manner. I had a rim soldered all round in the shape of a gutter, the edge of the lid sinking into the bottom of the gutter, and I then filled the latter with small shot, and thus obtained a most perfect closure. This box has been in use ever since, and with the addition of a wooden tray and of an iron vessel full of calcium chloride, has done me very good service.

I should not have mentioned so insignificant a circumstance were it not that it led me to a method for shutting out light and air that seems me to be new, and might be of service to some one or other of our confrères.

WASHING GELATINE EMULSION.

I am much surprised, when reading photographic papers, to see what rough appliances are often recommended for performing delicate operations with the most fickle of all materials, viz., gelatino-bromide emulsions. None of us would use anything but porcelain vessels of suitable form for most domestic purposes, but as soon as photography is concerned, many are content with materials such as string, earthenware, canvas, and the like.

Now a good apparatus means saving of time, certainty in the operations, and the avoidance of endless annoyances I have tried the different methods proposed for cutting up and washing my emulsions; forcing it through canvas, which is indeed a most disagreeable and unclean operation; cutting it up with a silver fork won't do, because the instrument tears rather than cuts.* I prefer a small roller with a number of sharp silver disks set up about a quarter of an inch apart (Fig. 2), and all mounted by means of silvered copper wire to a wooden handle. The disks are easily obtained by thinning out and sharpening small pieces of money. Having poured out the emulsion in a large porcelain tray, and let it set thoroughly, I pour clean water over it, and by rolling the above instrument to and fro, easily cut it up in long strips or ribbons.

FIG. 2.

For washing, I tried the washing bottle system, but some pieces of emulsion stick to the bottom of the bottle, and don't get washed at all, so I tried suspending it in a muslin bag in a vessel through which a stream of running water circulated. This is good, but very slow, and it is disagreeable to have to scrape the washed emulsion off the cloth, to which it adheres. Leading the water directly into a canvas bag containing the emulsion is the worst of all methods, since the emulsion is apt to fill the pores of the cloth, and stop the flow of water, so that this frequently overflows, and causes other accidents. At last I procured a porcelain vessel pierced with numerous small holes—I might almost call it a porcelain basket. This I placed in a large stoneware jar with an arrangement for filling and emptying automatically with water (Fig. 3). The emulsion, cut up into ribbons, being placed in the porcelain basket, is easily and thoroughly washed without clogging the holes, since the water passes them alternately in opposite directions, and the operation of draining and collecting the emulsion is comparatively an easy matter.

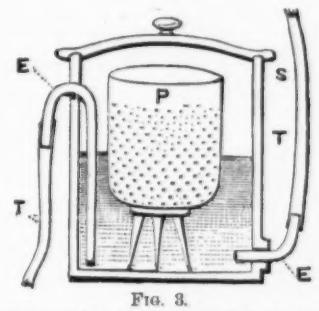


FIG. 3.

S, stoneware jar; E E, ebonite pipes; T T, india-rubber tubing; P, porcelain basket filled with emulsion, cut up into strips.

I find, by the way, that two parts of Simeon's Swiss gelatine, and one part of Nelson's No. 1, give a jelly that retains exactly its original volume, even after forty-eight hours' soaking in cold water. Simeon's gelatine alone under the same circumstances loses part of its water, and contracts to a smaller volume.

My washing apparatus much resembles a common sponge holder. Does not emulsion washing deserve a special vessel as well as the drying of a sponge? And if so, is it so very difficult to get a maker to alter the size and shape of his sponge-holder, and supply photographers with a most useful appliance?

COOKING EMULSIONS.

Some years ago I noticed in a Paris exhibition a most ingenious contrivance for cooking meat; it was termed a *cuisine Suédoise*. It consists of two vessels, fitting into one another and closing tightly, the space between the two being filled up with a non-conducting material such as wool or feathers (Fig. 4).* I had a similar apparatus made for my use; but with this difference, that the inner vessel had

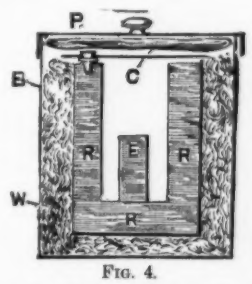


FIG. 4.

B, wooden box: L, lid to the same; W, space filled with wool; R, double-walled reservoir filled warm water; C, cover to the same; P, pillow filled with eiderdown; E, emulsion.

double walls and can be filled with warm water of a known temperature. When well closed, this temperature keeps unchanged for hours and days together. It proved a most efficient digesting apparatus. When I came to cook emulsions, I naturally used my Swedish kitchen, filling the reservoir with water of 70° C., and after a day and a half the cooking was completed with an ease and security quite unknown with any other contrivance. Seeing that many persons complain about the boilers actually in use, I venture to predict that my apparatus will shortly supersede them all.—*Photo News.*

A WIRE fence, running from Indian Territory west across the Texas Panhandle, and 35 miles into New Mexico, is projected and largely under contract. Its course will be along the line of the Canadian River, and its purpose is to stop the drift of the northern cattle. The fence will be over 200 miles long.

* I have not tried forcing the emulsion through an iron grating, nor do I intend to do so, as the contact with metallic iron is too great an outrage to my sense of what is suitable.

* The meat of a chicken thoroughly warmed on the fire is put into this inner space, and, after closing the lid, will be found perfectly cooked in a few hours, since the heat cannot escape.

THE MICROSCOPE IN DISEASE.

PARASITES in the intestines of all animals are developed, and they feed upon the system, and, if too numerous, cause disease and death. Parasites in the intestines of children and aged persons are very common, and if very numerous prove fatal. These and many others are visible to the naked eye. Had we the visual power to see all things as though we were looking through a microscope of high power, we would be amazed at the numerous animal life that is not visible to the unassisted eye. The air we breathe, the water we drink, and the food we eat is contaminated with bacteria, which poisons our systems and sows the seeds of disease, and in many cases death is the result. A lady some time ago sent me a slice of cold bacon ham for examination under the microscope, and stated that her family had been eating the ham, and that some of them were sick, and that she was fearful the ham was the cause. The ham had the appearance of having been sprinkled with fine black pepper. I scraped off some of it and placed it under the microscope, and it revealed animal life in abundance, and so active as to move from under the field of the glass. I have examined quite a number of specimens from different hams of bacon that had been boiled some days, and found the same peculiar animalcules.

The microscope is the only means by which trichinæ can be detected. They are not visible to the unassisted eye. I have found bacteria in the vomited matter from patients suffering from typhomalarial fever, and by experiments with different chemicals I ascertained what would destroy them, and the patient recover very rapidly under its exhibition.

By the aid of the microscope we can detect bacteria in the urine of patients suffering from acute or chronic cystitis, and by experiments with chemicals ascertain what will destroy them, and the patient speedily recover under its use.

A gentleman called on me a few months ago and stated that he had been under treatment for stricture of the urethra for the last twelve months, and that he was no better than when the treatment was begun. The mode of treatment that he had been under was dilatation.

By an examination of his urine under the microscope I ascertained that he was laboring under a slight chronic catarrh of the bladder, and the urine contained bacteria, which was keeping up the irritation.

By the aid of the microscope we have ascertained that the so-called "fur" on the tongue of patients is due in a great measure to certain forms of "fungi."

Dr. Hunter, a German savant, has devised a simple arrangement which demonstrates the circulation of the blood by making it visible.

Dr. Hunter's method is as follows: The patient's head is fixed in a frame, on which is a contrivance for supporting a miscroscope and lamp, his lower lip is drawn out and fixed on the stage of the microscope by means of strips, the inner surface must be uppermost, and having a strong light thrown on it by a condenser.

When these preparations are completed, all the observer has to do is to bring the microscope to bear on the surface of the lip, using a low power objective, and focusing a small superficial vessel. At once he sees the endless procession of the blood corpuscles through the minute capillaries, the colorless ones appearing like white specks dotting the red stream. He asserts that from taking careful notes as to variations in the blood-flow and changes in the corpuscles, he has derived great advantage in the treatment of those diseases.

The valuable assistance derived by the aid of the microscope in diagnosis of the kidneys and bladder is very great. I consider it indispensable in the successful treatment of those diseases.

For instance, chronic Bright's disease of the kidneys can be distinguished from an acute case. If we find renal casts and blood in the urine of a patient, it indicates a disease of a recent date, but if we find transparent or waxy casts, it indicates fatty degeneration of the kidneys.

If blood is from the kidneys, the corpuscles are equally diffused through the urine, but if from the bladder or urethra, the color is "pinkish or vermilion," and contains clots. If we detect uric acid crystals in the urine before it gets cold, or within six hours after it has been voided, the patient is in danger of having a calculus form in the bladder. This can be ascertained by the aid of the microscope, and then we can give remedies that will avert it. By the aid of the microscope we can detect a malignant tumor from a benign one, and pus from a strumous patient from that of a healthy subject.—*W. S. Ross, M.D.*, in *Western Medical Reporter*.

NOTES ON THE SPONGILLÆ OF BUFFALO.

THE presence of sponge in most diatomaceous deposits has led to the conclusion that sponges themselves may be looked for in all perennial running streams, brooks, or lakes. Facts of almost daily occurrence prove this conclusion to be correct, for whenever intelligent search has been made at the right season, the search has not been in vain. Among the first objects found in the microscopic examination of water from Niagara River were these transparent, pointed, slightly curved bodies, which the experienced microscopist recognizes as proof of the near presence of sponge. In October of 1879, Mr. D. S. Kellicott found the first specimen, on the pier at Black Rock, near Squaw Island. Subsequently three other species have been found by him and myself. One of them, we think, is new to science. All were named numerically, in the order found, till they could be identified.

No. 1. This most abundant species has been identified as *Spongilla asperima*. Dawson.

No. 2—*Carteralla tubisperma*. The specimens of this sponge found previous to the present season (1881) were so small and fragmentary that but a poor idea of its character and growth is given in my presentation of it, in a paper read before the Buffalo Microscopic Club in April, 1880. During October of this year I found it in large pieces, attached to weeds, under and upon rocks and stones and pieces of wood. In one or two instances I have found it as large as one's hand, and an inch and a half thick. It is generally green, but not always.

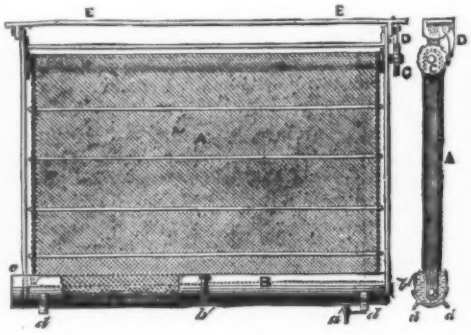
No. 3 is difficult to describe from specimens found in our locality. The action of the water upon the rocks where it is found is so great as to take away all the upper part of the sponge. We have identified it, however, with a species found in Philadelphia and named by Dr. Leidy *S. fragilis*. The ovarian capsules of statoblasts lie close together in a mass, incrusting rocks or any object in its way. Above these, and inclosing them, is the sponge proper, made up of spiculæ sarcode and other elements that constitute the spongillæ.

No. 4 is identical with a specimen found in the Ottawa River by Mr. Geo. Dawson, of Montreal, and named by him *S. ottawaensis*. From some cause it does not grow large in this locality. I found the largest pieces during last October that have been found. These were quite fragmentary, the sponge having been pierced through and through with numerous worms and other carnivorous animals that feed upon it.

Since penning the above, two other species, new to us, have been found in this neighborhood: one by Mr. E. S. Nott, of Hamburg, N. Y., and the other by myself in Niagara River. The one found by Mr. Nott, and sent to me for identification, I took to be *Spongilla carteri*, a species hitherto only found in Bombay, India. But, on a more thorough examination and subsequent comparison with a type-specimen from Mr. Carter's collection, I conclude that it is another species, probably new and undescribed.—*Henry Mills, in Bulletin of Buffalo Society of Natural Sciences.*

THE "CHEMICAL LUNG."

OVER twenty professional men and others interested in questions of sanitary science lately met together in London to witness one of Dr. Neale's demonstrations of his "chemical lung." The main features of the "lung," and the principal uses for which it is designed, have more than once been described in these columns, either by ourselves or by the inventor of the apparatus. In its inception, the "lung" was, we believe, chiefly intended for the purification of the air in the tunnels of the Underground Railway, though it has not been accepted for this purpose. When the details of the scheme were laid before the directors of the company, either the official mind failed to understand them, or official acuteness perceived that, so long as the public are willing to pay for traveling in a filthy atmosphere, the company need not be so generous (or foolish) as to undertake any additional trouble or expense in efforts to make the air even tolerably pure. Such may be, and doubtless is, a sensible and proper view for railway directors to take. They are not professional philanthropists, and as regards those who have charge of the Underground Railway, it may be predicted that when it can be shown that it is to their advantage and interest to make traveling on their line unobjectionable as well as convenient, they will adopt necessary measures and incur the requisite cost, but not till then. Meanwhile, the world is not made up of railway directors, and the "lung" will find fair scope for its activities elsewhere—as, for example, in theaters, churches, chapels, lecture-rooms, hospital wards, out-patient waiting-rooms, police-courts, ships' cabins, cellars, etc.



The "chemical lung" is really a punkah of peculiar construction, and supplied with a solution of a caustic alkali, for which many of the impurities of air vitiated by overcrowding have a special affinity. Not only are sulphurous and carbonic acid gases speedily removed from the atmosphere, but test experiments have shown that organic matters are likewise withdrawn by the "chemical lung" or punkah.

Subjoined is a description of the "lung," with an illustration: A is an endless cellular sheet passing over two rollers, the lower of which is sunk into a trough, B, which holds about three gallons of a saturated solution of a caustic alkali. (See diagram.) The apparatus is suspended from a bar, E E, attached to the ceiling of the room; and as the punkah swings to and fro a wheel and ratchet, C and D, cause the sheeting to revolve, one complete revolution of the sheet being accomplished about every four minutes. At *b'* is a water-gauge to indicate the amount of fluid contained in the trough; *c* is a pocket where the water and pieces of caustic alkali are supplied to the trough; *a'* is a tap for drawing the solution from the trough; and *d d* are feet for the punkah to stand on when not hanging up.

The experiments performed at the demonstration were similar to those of Dr. Neale. Their success was strikingly and marvelously complete. In a room 18 ft. by 15 ft., and 8 ft. 6 in. high, at the basement of the house, with the windows and door closed, fifty jets of a gas-stove were kept in full flame for an hour before the meeting. The temperature of the room was thereby raised to 85° F. A quarter of an ounce of sulphur was then burned in the room, rendering the air almost irrespirable, except through handkerchiefs, and exciting violent coughing. The punkah, charged with a solution of caustic soda, was then set in motion. In ten minutes the temperature had fallen 15° F., and though over twenty persons were present, each having an allowance of only 100 cubic feet, the air was rendered not only comparatively but positively fresh, and actually provocative of deep and full inspirations.

It is obvious that by means of the "chemical lung" not only may foul air be purified, but air may be prevented from becoming vitiated in crowded rooms, and this with extraordinary certainty and at a cost and inconvenience that are almost inappreciable.

DANGERS OF WELL WATER.

A SERIOUS difficulty recently occurred at Berlin in connection with a system of supply of "ground water" by "natural filtration" (a part of the Berlin water supply having been taken since 1877 from near the Tegeler Lake, by means of a series of twenty-three wells running parallel with the shore; the water was pumped into a small covered reservoir, then to another at Charlottenburg, six or seven kilom. distant, whence pumps supply the city). Complaints arose on account of the water, though clear at first, getting turbid ere long, and depositing an ocherous sediment found to consist of amorphous hydrated oxide of iron, but also very largely of algæ, dead and alive; *Crenothrix kühniana* (a plant of thready form) being most noticeable. The source of the plants could neither be located in surface water nor in the neighboring lake; and there is reason to believe the plant lives and grows in the ground itself. After sundry attempted remedies it seemed that artificial filtration would be necessary. It was found that water brought directly from the wells to the filter gave, after filtration and rest, the usual deposit. But by exposing this well-water to the air, so that all the iron was oxidized and deposited before filtration, it was possible to get a filtered water which remained clear; though it is not known whether this filtered water was really free of spores, and would continue clear after being in contact with the iron of the service. Iron seems essential to the existence of *Crenothrix*, and is proved to be present in its threads. The filter-sand was very much fouled, and, because of the difficulty of keeping out spores, it was thought best to abandon the wells altogether, and to use water taken directly from the lakes and filtered in the usual way. Prof. Nichols (who reports these facts in the Franklin Institute *Journal*) refers to somewhat similar troubles having been experienced at Halle, and at a town in the east of Massachusetts.

THE ARRIVAL OF MAN IN EUROPE.

By JOHN FISKE.

TOWARD the close of the Pleistocene age, the general outlines of the European continent had assumed very much their present appearance everywhere except in the northwest. The British Islands still remained joined to one another and to the Gaulish mainland, and occupied the greater part of the area of the German Ocean. According to Mr. James Geikie, the connection with Norway again became complete, and the Atlantic ridge was again so far elevated as to bring Scotland into connection with Greenland through the Färoe Islands and Iceland. The whole of Britain stood at an average elevation of from 600 to 1,000 feet above its present level. The Thames, Humber, Tyne, and Forth must all have flowed into the Rhine, which emptied itself into the North Sea beyond the latitude of the Shetlands. The glaciers of Europe had retreated within the Arctic Circle, or up to the higher valleys of the great mountain ranges; and the climate was beginning to assume its present temperate and equable character.

At this remote epoch Europe had already been inhabited by human beings during several thousand years. How long before the beginning of the Pleistocene period man had arrived in Europe is still open to question; but there is no doubt whatever that he lived in Gaul and Britain as a contemporary of the big-nosed rhinoceros, and before the arrival of the Arctic mammalia which were driven from the north as the glacial cold set it. This race of man—described by Mr. Boyd Dawkins as the "River-drift-Man"—is probably now as extinct as the cave-bear or the mammoth. Late in the Pleistocene period it disappeared from Europe, and was replaced by a new race, coming from the northeast, along with the musk sheep and reindeer, and called by the same eminent writer the "Cave-Man." Both the Cave-men and the River-drift men were in a stage of culture known as the Palæolithic, or Old Stone Age; that is, they used only stone implements, and these implements were never polished or ground to a fine edge, but were only roughly chipped into shape, and were very rude and irregular in contour. The Palæolithic Age, referring as the phrase does to a stage of culture, and not to any chronological period, is something which has come and gone at very different dates in different parts of the world. It may be convenient to remember that in northwestern Europe it seems to have very nearly coincided with the Pleistocene period, provided we also bear in mind that the coincidence is purely fortuitous.

The implements of the River-drift men, found in Pleistocene river-beds, are very rude, and imply a social condition at least as low as that of the Australian savages of the present day. "They consist," says Mr. Dawkins, "of the flake; the chopper or pebble roughly chipped to an edge on one side; the *hâche* or oval-pointed implement, intended for use without a handle; an oval or rounded form with a cutting edge all round, which may have been used in a handle; a scraper for preparing skins; and pointed flints used for boring." Man did not then seek for the materials out of which to make these weapons or tools, but "merely fashioned the stones which happened to be within his reach—flint, quartzite, or chert—in the shallows of the rivers, as they were wanted, throwing them away after they had been used." No pottery of any sort has been found in association with these implements, nor were there at that period any domesticated animals. The River-drift men were evidently no tillers of the ground, neither were they herdsmen or shepherds; but they gained a precarious subsistence by hunting the great elk and other deer, and contended with packs of hyenas for the caves which might serve for shelter against the storm. As to what may have been the social organization of these primeval savages, nothing whatever is known. They were a wide-spread race. Their implements have been found, in more or less abundance, in Britain, Germany, France, Spain, Italy, Greece, Northern Africa, Palestine, and Hindostan. Their bones have been found in the valleys of the Rhine, the Seine, the Somme, and the Vezère in sufficient numbers to show that they were dolicocephalic or long-headed race, with prominent jaws, but no complete skeleton has as yet been discovered.

These River-drift men, as already observed, belonged to the southern fauna which inhabited Europe before the approach of the glacial cold. As the climate of Europe became arctic and temperate by turns, the River-drift men appear to have by turns retreated southward to Italy and Africa, and advanced northward into Britain, along with the leopards, hyenas, and elephants, with which they were contemporary. But after several such migrations they returned no more, but instead of them we find plentiful traces of the Cave-men—a race apparently more limited in its range, and clearly belonging to a sub-arctic fauna. The bones and implements of the Cave-men are found in association with remains of the reindeer and bison, the arctic fox, the mammoth, and the woolly rhinoceros. They are found in great abundance in southern and central England, in Belgium, Germany, and Switzerland, and in every part of France; but nowhere as yet have their remains been discovered south of the Alps and Pyrenees. A diligent exploration of the Pleistocene caves of England and France, during the past twenty years, has thrown some light upon their mode of life. Not a trace of pottery has been found anywhere associated with their remains, so that it is quite clear that the Cave-men did not make earthenware vessels. Burnt clay is a peculiarly indestructible material, and where it has once been in existence it is sure to leave plentiful traces of itself. Meat was baked in the caves by contact with hot stones, or roasted before the blazing fire. Fire may have been obtained by

friction between two pieces of wood, or between bits of flint and iron pyrites.

Clothes were made of the furs of bisons, reindeer, bears, and other animals, rudely sewn together with threads of reindeer sinew. Even long fur gloves were used, and necklaces of shells and of bears' and lions' teeth. The stone tools and weapons were far finer in appearance than those of the River-drift men, though they were still chipped, and not ground. They made borers and saws as well as spears and arrow-heads, and beside these stone implements they used spears and arrows headed with bone, and daggers of reindeer antler. The reindeer, which thus supplied them with clothes and weapons, was also slain for food; and, besides, they slew whales and seals on the coast of the Bay of Biscay, and in the rivers they speared salmon, trout, and pike. They also appear to have eaten, as well as to have been eaten by, the cave-lion and cave-bear. Many details of their life are preserved to us through their extraordinary taste for engraving and carving. Sketches of reindeer, mammoths, horses, cave-bears, pike and seals, and hunting scenes have been found by the hundred, incised upon antlers or bones, or sometimes upon stone; and the artistic skill which they show is really astonishing. Most savages can make rude drawings of objects in which they feel a familiar interest, but such drawings are usually excessively grotesque, like a child's attempt to depict a man as a sort of figure eight, with four straight lines standing forth from lower half to represent the arms and legs. But the Cave-men, with a piece of sharp-pointed flint, would engrave, on a reindeer antler, an outline of a urus so accurately that it can be clearly distinguished from an ox or a bison. And their drawings are remarkable not only for their accuracy, but often equally so for the taste and vigor with which the subject is treated.

Among uncivilized races of men now living, there are none which possess this remarkable artistic talent save the Eskimos; and in this respect there is complete similarity between the Eskimos and the Cave-men. But this is by no means the only point of agreement between the Eskimos and the Cave-men. Between the sets of tools and weapons used by the one and by the other the agreement is also complete. The stone spears and arrow-heads, the sewing needles, and skin-scrapers, used by the Eskimos are exactly like the similar implements found in the Pleistocene caves of France and England. The necklaces and amulets of cut-teeth and the daggers made from antler, show an equally close correspondence. The resemblances are not merely general, but extend so far into details that if modern Eskimo remains were to be put into European caves they would be indistinguishable in appearance from the remains of the Cave-men which are now found there. Now, when these facts are taken in connection with the facts that the Cave-men were an Arctic race, and especially that the musk sheep, which accompanied the advance of the Cave-men into Europe, is now found only in the country of the Eskimos, though its fossil remains are scattered in abundance all along a line stretching from the Pyrenees through Germany, Russia, and Siberia—when these facts are taken in connection, the opinion of Mr Dawkins, that the Cave-men were actually identical with the Eskimos, seems highly plausible. Nothing can be more probable than that, in early or middle Pleistocene times, the Eskimos lived all about the Arctic Circle, in Siberia and Northern Europe as well as in North America; that during the coldest portion of the Glacial period they found their way as far south as the Pyrenees, along with the rest of the sub-arctic mammalian fauna to which they belonged; and that, as the climate grew warmer again, and vigorous enemies from the south began to press into Europe and compete with them, they gradually fell back to the northward, leaving behind them the innumerable relics of their former presence, which we find in the late Pleistocene caves of France and England. The Eskimos, then, are probably the sole survivors of the Cave-men of the Pleistocene period; among the present people of Europe the Cave-men have left no representatives whatever.

With the passing away of Pleistocene times, further considerable changes occurred in the geography of Europe and its population. Early in the recent period the British Islands had become detached from each other and from the Continent, and the North Sea and the English and Irish Channels had assumed very nearly their present sizes and shapes. The contour of the Mediterranean, also, had become nearly what it is now; and in general such changes as have occurred in the physical structure of Europe during the recent period have been comparatively slight. Of the mammalia living at the beginning of this period, only one species, the Irish elk, has become extinct. The gigantic cave-bear, the cave-lion, the mammoth, and the woolly rhinoceros had all become extinct at the close of the Pleistocene period, and the elephants and hyenas had finally retreated into Africa. In Europe were now to be found the brown and grizzly bears, the elk and reindeer, the wild boar, the urus or wild ox, the wolf and fox, the rabbit and hare, and the badger; and along with these there came those harbingers of the dawn of civilization—the dog and horse, the domestic ox and pig, with the sheep and goat. A new race of men, also, the tamers and owners of these domestic animals, had appeared on the scene. These new men could build rude huts of oak logs and rough planks, made by splitting the tree trunks with wedges. Such work was not done with chipped flint-flakes. The men of the early recent period had the grindstone, and used it to put a fine edge on their stone hatchets and adzes; so that their appearance marks the beginning of a new era in culture. The sharp and accurate edge of the ax, unattainable save by grinding, is the symbol of this new era, which is known to archæologists as the Neolithic, or New Stone Age.

The huts of the Neolithic farmers and shepherds were built in clusters, and defended by stockades. Wheat and flax were raised, and linen garments were added to those of fur. The distaff and loom, in rude shape, were in use, and grain was pounded in the mortar and pestel. Rude earthenware vessels were made, sometimes ornamented with patterns. Canoes were also in use. The dead were buried in long barrows, and from the almost constant presence of arrow-heads, pottery, or trinkets in these tombs, it has been inferred that the Neolithic men had some idea of a future life, and buried these objects for the use of the departed spirits, as is the custom among most savage races at the present time.

The celebrated lake-villages of Switzerland belong to the Neolithic or early recent period; and the remains of their cattle, and of their cultivated seeds, and fruits, have thrown light upon the origin of the Neolithic civilization. It is certain that the domestic animals did not originate in Europe, but were domesticated in Central Asia, which was the home of their wild ancestors; and, moreover, they were not introduced into Europe gradually, and one by one, but suddenly and *en masse*. It is clear, therefore, that they must have been brought in from Asia by the Neolithic men; and the same is true of the four kinds of wheat, two of barley, the millet, peas, poppies, apples, pears, plums, and flax, which grew in the gardens and orchards of Neolithic Switzerland.

This rudimentary Neolithic civilization was spread all over Europe, with the exception of the northern parts of Russia and Scandinavia; and there can be no doubt that it lasted for a great many centuries. It certainly lingered in Gaul and Britain long after the valley of the Nile had become the sent of a mighty empire; perhaps even after the Akkadian power had established itself at the mouth of the Euphrates, and "Ur of the Chaldees" had become a name famous in the world. Still more, it is clear that the Neolithic population has never been swept out of Europe, like the Cave-men and the River-drift men who had preceded it, but has remained there, in a certain sense, to this day, and constitutes a very important portion of our ancestry.

So many skeletons have been obtained of the men and women of the Neolithic period that we can say, with some confidence, that the whole of Europe was inhabited by one homogeneous population, uniform in physical appearance. The stature was small, averaging 5 feet 4 inches for the men, and 4 feet 11 inches for women; and the figure was slight. The skulls were "dolicocephalic," or long and narrow; but the jaws were small, the eyebrows and cheek-bones were not very prominent, the nose was aquiline, and the general outline of the face oval and probably handsome. In all these points the men of the Neolithic age agree exactly with the Basks of Northern Spain, the remnant of a population which at the dawn of history still maintained an independent existence in many parts of Europe. By their conquerors, the Keits, who led the van of the great Aryan invasion of Europe, these small-statured Basks were known as "Iberians" or "Westerners" (Gael *iver*, Sanskr. *avara*, "western"), and "Iberian" is now generally adopted as the name of the race which possessed the whole of Europe in the Neolithic age, and until the Aryan invasions, and which still preserves its integrity in the little territory between the Pyrenees and the Bay of Biscay. The Iberian complexion is a dark olive, with black eyes and black hair; so that we may figure to ourselves with some completeness how the prehistoric inhabitants of Europe looked.

It is probable that in Neolithic times this Iberian population was spread not only all over Europe, but also over Africa north of the Desert of Sahara; so that the Moorish and the Berber peoples are simply Iberians, with more or less infusion of blood from the Arabs, who conquered them at the end of the seventeenth century after Christ. And it is also probable that the Silures of ancient Britain, the Ligurians of Southern Gaul and Northern Italy, and the rich and powerful Etruskans all belonged to the Iberian race.

In very recent times—probably not more than twenty centuries before Christ—Europe was invaded by a new race of men, coming from central Asia. These were the Aryans, a race tall and massive in stature (the men averaging at least 5 feet 8 inches, and the women 5 feet 3 inches), with "brachycephalic" or round and broad skulls, with powerful jaws and prominent eyebrows, with faces rather square or angular than oval, with fair, ruddy complexions and blue eyes, and red or flaxen hair. Of these, the earliest that came may perhaps have been the Latin tribes, with the Dorians and Ionians; but the first that made their way through western Europe to the shores of the Atlantic were the Gael, or true Kelts. After these came the Kymry; then the Teutons; and finally—in very recent times, near the beginning of the Christian era—the Slavs. These Aryan invaders were further advanced in civilization than the Iberians, who had so long inhabited Europe. They understood the arts which the latter understood, and besides all this, they had learned how to work metals; and their invasion of Europe marks the beginning of what archæologists call the Bronze Age, when tools and weapons were no longer made of polished stones, but were wrought from an alloy of copper and tin. The great Blonde Aryans everywhere overcame the small brunette Iberians, but, instead of one race exterminating or expelling the other, the two races everywhere became commingled in various proportions. In Greece, Southern Italy, Spain, and Southern France, where the Iberians were most numerous as compared with the Aryan invaders, the people are still mainly small in stature and dark in complexion. In Russia and Scandinavia, where there were few Iberians, the people show the purity of their Aryan descent in their fair complexion and large stature. While in Northern Italy and Northern France, in Germany, and the British Islands, in Iberian and Aryan statures and complexions are intermingled in endless variety.—*Atlantic Monthly.*

NOTES ON THE COTTON INDUSTRY OF INDIA.

By AN INDIAN MILL MANAGER.

THE cotton industry of India is perhaps the oldest of all its numerous manufactures, and, like the whole of these, the mode of conducting it is simplicity itself. Yet, like all crude attempts at manufacturing, in its process from the raw to the finished article, it is both wasteful and clumsy. The raw cotton, which is an indigenous product of the country, is taken from the pod and drawn into an irregular thread, by hand, by the simplest means, and the warp for the loom is measured by walking round two sticks placed at certain distances from each other. After the required number of threads to form the warp are stretched round these sticks the end is cut, and the operator rolls the whole into a ball, as our ball warpers in England do. It is then taken to the loom, which consists of a rude wooden roller, fitting into two posts driven into the ground, the roller only being raised a few inches from the floor. A hole is dug in the earth below the center of the roller, into which the weaver puts his legs, the ground serving as a seat. He then draws the ends of the warp through the reed, which is made of fine bamboo, and makes them fast to the roller. The warp is then stretched to its full length, and the required number of staves are put in to keep it spread the proper width, a large stone being tied to the last stave to retain it in the stretched position. The warp is next dressed by means of a brush, when as much starch or size is put upon the yarn as it is possible to get on consistently with working well. The shuttle is rudely made out of wood, and is thrown across the shed by hand, first with one hand and then the other. At each throw the bamboo sley is knocked up by hand twice to bring the weft close together. As the cloth is formed in the loom the roller is turned by hand, and thus the cloth gets wrapped round the roller. Many of these weavers travel from place to place, carrying a few pounds of yarn upon their backs and the loom under their arms, stopping at any man's door who will engage them to make a piece of cloth They can go into the bazaars and buy just the quantity of yarn required to make any length of cloth, and so need keep no stock. Anything more simple or inexpensive to the people at large could scarcely be conceived. The fine muslins for which India has such a name are made out of foreign fine yarns imported either direct or indirect, these being now rarely, if ever, spun in the country. This simple system has been largely destroyed by the importation of English goods, and later on by the introduction of the English system. The first mill for spinning cotton by steam power was erected at Broach, over twenty years ago, and the second one in Bombay, at a place called Tardeo. The latter was built by an enterprising Parsee, who it is said was assisted by government in his then arduous undertaking. This man may truly be called the father of the cotton industry in Bombay. The new trade has been steadily on the increase ever since, so that at the present time it is one of the most important wealth-producing industries of the country, giving employment to thousands of people.

The time of labor on the first introduction of the English system of cotton spinning into the country was ten hours per day; and although these hours paid, still they were increased until they now extend from daylight until dark all the year round, Sundays included. The longest hours I have known worked have been 13½ hours, and the shortest 11 hours per day. This excludes half an hour allowed at most mills for the hands to eat their dinner and oil the machinery. The mills generally stop every second or third Sunday, to clean the boilers and machinery, and for general repairs, etc., but only one mill that I know stops every Sunday, and this mill, as a rule, has been the most prosperous, and paid the highest dividends. But with these long hours the employers as a body are not satisfied—it actually being under discussion to work the mills night and day, by employing two sets of hands. Some years ago one mill did try this plan, but the hands would not go out in the dark to perform the calls of nature, and rendered the rooms unfit for those who had to follow them, so it had to be abandoned.

The mills in India, with few exceptions, are in the hands of limited companies, the members of which are mostly natives, one individual or one family generally possessing the majority of the shares, or the voting influence of the majority of the shares, so that they rule as they like. In most cases this individual, or family, is the agent, or agents for the mill. An agent in India is something more than what is understood by an agent in England. He receives a commission on every pound of yarn or cloth turned out from the mill, amounting to something like a farthing a pound on every pound of the production. Then he obtains commission on all he buys. It is an extravagant and unsound system, as the agent gets paid whether the shareholders get any dividend or not. In many instances the agency is for life, in others for a term of years, and in others it is hereditary, descending from father to son, as long as the company exists.

The cost of a mill is extravagantly high. It is considered but a small sum to clear £5,000 out of a building to hold 50,000 spindles. There are many faults in the construction of most mills that would not be tolerated in this country, all of which tend to increase the cost of production. They seem, however, to have got into a certain groove, and it will take time to get them out of it. It would be a good thing if the native contractors and engineers would visit our English mills and study their construction. The consumption of coal is about 4 lb. per horse power, the price of which has been as high as £2 per ton.

The workpeople are thin and slimly built; from 60 lb. to 70 lb., I should say, is the average Hindoo's weight. The Mohammedans are heavier and stronger, because they live better. The natives, as a rule, are of a suspicious disposition, inclined to take a narrow view of things in general. They are passionate in temper if irritated, but soon calm down. In their usual mood they are affectionate, good tempered, witty, fond of practical joking, and are attached to any one that shows kindness to them, and look with every confidence to the Englishmen that are placed over them. Generally they are truthful—it being a religious point with them to be so. They are well suited for mill work, being attentive and obedient, and quick to learn, but require to be well looked after. They are glad to learn anything new, and when they have, as they think, mastered one kind of work in the mill, they want to be removed to some other work, and so on, so that they become "jacks of all trades, but thorough masters of none." I have known an educated native go through the whole mill in nine months, believing himself afterward capable of managing it both practically and theoretically. This self-delusion is pitiable, but it is a fault that extended education and experience only will remedy. They will eventually come to understand each part of the work thoroughly. They have a great desire to get more money, and if a situation in the mill falls vacant, lots of applications are received from other departments in the mill, especially if the vacancy carries more money with it than the applicants are already getting. They make an application even if they know nothing about the work, as that with them is of secondary consideration, extra money being the sole object they seek in order that they may be enabled to purchase more of the comforts and necessaries of life. The Hindoos, the native Christians, and the Parsees are the most willing workers. The Mohammedans, as a rule, are opposed to any change, because their religion forbids it, while the others gladly take up any improvement. The Mohammedan is taught to look upon himself as the salt of the earth.

The people are physically weak, and there are many causes to account for this—early marriages being one of the chief; children bring forth children before they themselves are properly developed. The increase of the population springing from this custom has rendered the great army of workers most wretchedly poor, their wages being equal to but bare existence, which compels them always to live upon the same common food, which is a low vegetable diet, with chillies as a stimulant. These chillies taken to excess cause blindness, or partial blindness—indeed, few of the lower class of natives can see at all in an artificial light. Lung diseases are prevalent, from a want of sufficient clothing to meet the changes in the temperature. Also skin diseases, not caused by dirt, but from a lack of means to buy that wherewith to keep their bodies clean, and in a state of health such as the working classes of England can get. The workpeople seem to be valued only for the amount of work that can be ground out of them at the bare price of existence. And what an existence it is no one can ever paint, and words fail to describe it. What one man or woman gets in wages does not say what they have depending upon them, for in one miserable room, say ten feet square, there may be ten to fifteen individuals living, all members of one family, cooking and sleeping in the same place, with no outlet for the smoke but the door, or, if one story, through the crevices in the tiles or thatch. The rent of such a room would be 4s. per month. There is a sad want of building regulations that would control footpaths, the width of streets, and form all buildings

into square blocks, which would tend to good and regular ventilation. As it is, all is left to the freak of the capitalist or builder.

The kindness of the people to each other in times of distress is beyond all praise, and it is time the government stepped forward to regulate the dealing out of something like justice to the most helpless of the helpless. It cannot be wondered at if these people take every opportunity they can of being dishonest, as their existence is so wretched that when temptation comes in their way it is too much for them to resist. It is said that these people are unimpressionable, but do them a kindness, and it will soon be seen that such an idea is absurd. They have been conquered by different peoples so often, and subjected to gross cruelties and indignities so long, that the great mass have become impassive, and live without hope, looking forward to death only as a happy relief. While we are waiting for the growth of public opinion upon social questions, these people are dying off like dogs, and not the slightest notice is taken of them. It is all put down to disease brought on by laziness, dirt, or inertness on the sufferers' part, when there is no one to guide them, no one to teach them, and no political organizations to lift a finger toward the remedy of their wrongs. The Indian priesthood, with all its intelligence, works nothing but sedition against the government, and grinds all it can out of the people. Its motto is, "Give, give. Let me have all and live. Grind down the people, keep them servile." If English workingmen could but see their fellow Indian subjects they would highly prize their public men. If the educated natives of India could but change places with the working classes of India there would soon be a cry for reform of existing abuses. Few of the educated natives look to trades for a livelihood, which is a mistake; teaching or clerkships are their great aims until these are overdone. Trade or dirty work is considered to break their caste. Government could do a good work here by encouraging them to take up with trades, and treating the natives less as a conquered race.

There are some few educated natives among what may be called the working class of India, and these take a pride in adopting English manners, and in educating their children. The girls they educate at home. The educated natives generally look down upon the working classes as coolies—this being the lowest term to apply to a working man, and there are millions in India who belong to no caste at all, but who will eat or drink anything, or do any kind of work. They make the best and most willing workers, and if only looked to by the government, and educated, they would become a great power in India. As it is, the other castes exclude them from the government schools. Schools ought to be established that could reach these people, and compulsory laws of attendance should be established and enforced. An education act ought to go side by side with the factory act. To all mills a night school might be attached, in which English should be taught. Some mills already have night schools attached, and all honor to the few that attend them. The children who go to the day schools seem glad to go, and their bright merry faces are a pleasure to look upon, as they are seen going to school at 6 A.M., with books, slate, pen, and inkstand slung in their hands. Schooling for girls is sadly wanted. The language of the country is not a practical language, technically speaking, so that the study of English ought to be encouraged by every possible means among the working people. The working classes say they are in the dark "Give us an education, and then we shall have sense."

The people are, as a rule, sober, drinking little if any intoxicating liquors. Upon all great holidays the liquor shops are closed against the natives. The common drink is water, and above all things it ought to be pure. A supply of pure water is much wanted throughout India, with an abundance of drinking fountains in all public places, for general use. The water would then be fresh drawn, as wanted. The public wells and tanks should be closed; as they are a public nuisance, being nothing more than cesspools, fruitful of disease and death. Government servants have a rest-day, and most of the shops and offices close one day a week, but there is no rest-day for the mills. How does the absence of this affect the factory operatives? Why, in personal cleanliness. It prevents them from keeping their bodies and clothes clean. In a mill it is a common thing to see the operatives picking vermin from their clothes and carefully putting them on the floor to prevent them from being hurt, as it is a violation of their religious principles to take life. The holidays in the year that affect the working of the mills amount to eleven, and these are all worked up by the excuse of using Sunday as a work-day. The mills, indeed, would never stop at all if it was not for cleaning the machinery. The Sunday rests and holidays are the only times the people have either to wash their persons or their clothes properly. They are not naturally inclined to be dirty, but what can the poor creatures do, while they have so few opportunities of securing cleanliness? Their clothes, for a want of means to buy more, rarely consist of more than those they work in, and these have to be roughly and hurriedly washed in cold water, which operation is oftener than not performed beside the well or tank from which the drinking water is derived, so that it requires but a very little stretch of the imagination to comprehend the amount of filth that gets into what ought to be pure drinking water. Public baths and properly arranged washing places are much needed. While matters remain as they are, there is hardly any need to wonder why cholera, smallpox, and fevers of all descriptions are so rife in what ought to be one of the healthiest countries in the world. Society is shocked, and puts all the blame on a poor and helpless people, when the blame lies at other people's doors. Such a state of things is a disgrace to any nation, let alone ours, which, as the most scientific nation in the world, ought to insist on these things being quickly altered.—*Textile Manufacturer.*

PEACH CULTURE.

THE obstacle to successful peach culture in the New England States is the disease known as the "yellows," a disease which has thus far baffled all efforts to cure. It is not confined to any one variety of the fruit, nor is it influenced by any method of soil fertilization, so far as our observation goes, and variations in seasons do not promote or retard the steady march of the disease. We have a peach orchard on a field which has had no animal manures applied to it for twenty years, and we have trees on soils which have received dressings of various forms of excrement, but in all instances the yellows have speedily completed their fatal work.

Noticing in the annual report of the Massachusetts Agricultural College the remark made by Professor Maynard, of the botanical department, that the peach trees on the farm which had been attacked by the yellows were now in apparently good condition, and free from the disease, we wrote to him, asking if he would give some further information upon the subject. As the remark implied that a "cure" had in some way been effected, it was very desirable to know how it had been accomplished. Professor Maynard replies as follows:

"We have a number of peach trees that have shown every indication of disease, and which are to-day as healthy as any trees on the place.

"In our experience we find that trees are not attacked by this disease unless the soil becomes poor or the trees are weakened by overbearing. The top generally dies while the root remains alive for one season after the top appears dead. Our treatment has been, when a tree begins to show signs of weakness or disease, to cut back severely—not only the shoots but the main branches—then apply an abundance of plant food, and especially potash; but I think potash alone will not cure the disease. I believe if a few healthy cells can be produced the tree can be renewed in perfect health.

"The manure we have used has been muriate of potash, from three to four pounds to each tree, well distributed around the tree, ground bone or superphosphate, and some organic matter if the soil is very poor. We have used in some instances, with good results, Navassa phosphates, containing a large per cent. of iron, also manure from the blacksmiths' shops, which contains much iron.

"We do not claim to have discovered a positive remedy for the disease called the yellows, nor to have proven what that disease is, but we believe that by proper treatment the peach tree may be kept in a healthy condition for a long series of years, and produce an abundance of fruit when the buds are so matured as to withstand the cold."

If peach trees can be restored to health after they have been attacked, it is an important item of knowledge to know how to treat them. Our orchards have not suffered from want of nutriment, and potash in various forms of combination have been applied without success. Still, in our attempts to cure we have not cut back the trees so severely as recommended by Professor Maynard. Out of two hundred trees not more than twenty remain which have sufficient vitality left to warrant experiment, but we shall adopt the course indicated, and await results.—*Bos. Jour. Chem.*

OLEOMARGARINE AND LARD CHEESES.

AT A recent meeting of the Royal Agricultural Society of England, at which His Royal Highness the Prince of Wales was present as a member of the council, Lord Vernon, in his capacity as chairman of the dairy committee, brought forward a report, in which he stated that the attention of the committee had been drawn to samples of so-called cheese from America made with skim-milk and oleomargarine respectively, and they recommended that a letter be addressed to the President of the Board of Trade, urging that steps should be taken to insure that these descriptions of so called cheese be sold only under their proper designations. In making this recommendation, his lordship remarked that in the *Journal* of the society now about to be issued, there was an article on the manufacture of lard cheese, the writer being Mr. Willard, of New York State. Reporting on a visit to the factory of Messrs. Burrell and Whitman, that gentleman described the process of manufacturing lard cheese; and he had since sent over two samples of cheese, one made with lard and the other with oleomargarine. In the article there were one or two remarks to which he wished to call the attention of the council. He wrote: "There is much feeling among our dairymen against the making of this adulterated product, fears being entertained that if largely made and exported it will injure the sale of genuine whole-milk cheese. I think it not improbable that very strict laws will be passed regulating the sale and export of lard cheese. I am told that parties have shipped this cheese to England, and that experts were unable to detect the adulteration, and I have seen samples that would pass unsuspected for whole-milk cheese, both as to texture and flavor." With regard to the prices realized, Lord Vernon added that it was estimated by a London cheese factor at 56s. per cwt. wholesale, and that another gentleman gave his opinion that it was worth from 8d. to 9d. per lb. retail; while the writer of the article spoke of the prices obtained in the United States being within from 1c. to 2c. per lb. of whole-milk cheese sold on the Little Falls market. Mr. Willard concluded with these words: "That the lard cheese made at this factory has unquestionable merit, no one, I think, can reasonable deny; and this leads me to say that cheese as good as this ought to sell on its merits and under its own name to distinguish it from whole-milk goods, since it is right that the consumer should know what he was purchasing. As to lard cheese made elsewhere I cannot speak, not having had sufficient opportunity of testing its quality. I suppose lard cheese, however, is no exception to other kinds, and that its goodness and character depend considerably upon the skill of the maker." The editor, Mr. Jenkins, appended a note to the article, as follows: "A sample of lard cheese, and one of oleomargarine cheese, sent to me by Messrs. Burrell and Whitman, arrived as the *Journal* was going to press. I can indorse all that Mr. Willard says about the quality of the lard cheese, and the name under which it should be sold. The latter remark applies equally to the oleomargarine cheese, but its quality was very superior; in fact, it could not be readily distinguished from the ordinary American cheese of commerce." Lord Vernon went on to say that by the kindness of Mr. Jenkins he received a sample of each of the cheeses in question, and he entirely agreed with him as to the oleomargarine cheese being the better of the two. He was quite confident that no one but an expert could distinguish the difference between it and genuine cheese. Perhaps Dr. Voelcker would inform the council whether, in his opinion, there was any probability of detecting by chemical analysis any manufacture of what he termed—perhaps not quite accurately—spurious cheese.

Dr. Voelcker said that Mr. Jenkins had handed him samples of each of the cheeses referred to. He took them at once in hand for analysis, and found that the oleomargarine cheese contained about five per cent. more fatty matter than the lard cheese, the latter being rather poor in fat. He had no doubt that the excess of fatty matter accounted for the superiority of the oleomargarine cheese. The fat contained in the lard cheese had all the character of lard; but it was more difficult to ascertain the true nature of the fat extracted from the oleomargarine cheese. With regard to the exact question put by Lord Vernon, it would be extremely difficult by a superficial examination to detect the presence of either lard or oleomargarine in cheese; but on the other hand, he had no doubt that by a more elaborate chemical analysis he would be able to do this. There was no difficulty in detecting the presence of lard or oleomargarine in butter. He did not find anything unwholesome in it, and it was perfectly wholesome food.

The President said that in our butter factories the proprietors did not know how to get rid of the skim-milk, and he gathered that by the introduction of lard or oleomargarine to this skim-milk (which was at present very unnecessarily and very foolishly wasted), the dairy companies would be able to work up the refuse produce into a wholesome article of food. The cheeses so made appeared scarcely inferior to skim-milk cheese. One of the chief objects of the society was to encourage the making of butter, and one of the great obstacles in the way of butter-making was the difficulty of getting rid of the skim-milk. He thought the council should be very careful before writing to the Board of Trade to request their interference. It was a great question whether the public were not benefited by such forms of cheap and wholesome food.

Several other members continued the discussion, the majority being of opinion that it would not be prudent at present to appeal to the Board of Trade respecting the importation of oleomargarine cheese, and the recommendation was therefore withdrawn.

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